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DEVELOPMENT OF A DESIGN METHOD FOR
GLASS WINDOWS SUBJECTED TO BLAST LOADINGS

A Research Paper
by

DANIEL T. MAGRO
Lieutenant, Civil Engineer Corps, U. S. Navy

Submitted to the Department of Civil Engineering
Texas A&M University
in partial fulfillment of the requirements for the
degree of

MASTER OF ENGINEERING

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Abstract

The purpose of this research is to develop a method which can be used to predict the dynamic response of rectangular glass plates subjected to uniform blast loadings of varying durations. A computer code developed using an equivalent mass and force approach is presented. The results generated using this code are compared to results obtained from a detailed finite element solution and actual test data. The results of this comparison verify that the developed computer code provides a reasonable design tool.

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List of Symbols

| | |
|-----------|---|
| A | - Area of the Window Plate |
| a_0 | - A constant used in the Linear Acceleration Method. |
| a_1 | - A constant used in the Linear Acceleration Method. |
| a_2 | - A constant used in the Linear Acceleration Method. |
| a_3 | - A constant used in the Linear Acceleration Method. |
| a_4 | - A constant used in the Linear Acceleration Method. |
| a_5 | - A constant used in the Linear Acceleration Method. |
| c | - Damping |
| c_{cr} | - Critical Damping |
| E | - Modulus of Elasticity for Glass (10.4×10^6 psi) |
| h | - Window Plate Thickness |
| k | - System Spring Force |
| k_e | - Equivalent Spring Stiffness |
| K_L | - Equivalent Load Factor |
| K_M | - Equivalent Mass Factor |
| K_R | - Equivalent Resistance Factor |
| F_e | - Equivalent Force |
| F_{i+1} | - Forcing Function at time $i+1$ |
| F_r | - Incremental Force on finite area of plate |
| F_t | - Total Force on plate |
| $F(t)$ | - Force as a function of time |
| m | - Mass |
| m_e | - Equivalent Mass |

M_r - Incremental Mass on finite area of plate
 m_t - Total Mass
 P - Overpressure
 P' - Modified peak blast pressure
 q - Dimensionalized Load on Plate
 q - Nondimensionalized Load
 T' - Blast duration
 t_i - Time at beginning of time step
 t_{i+1} - Time at end of time step
 y_0 - First peak displacement for Log Decrement equation
 y_1 - Second peak displacement for Log Decrement equation
 y_i - Displacement at beginning of time step
 \dot{y}_i - Velocity at beginning of time step
 \ddot{y}_i - Acceleration at beginning of time step
 y_{i+1} - Displacement at the end of time step
 y - Displacement
 \dot{y} - Velocity
 \ddot{y} - Acceleration
 $y(t)$ - Displacement as a function of time
 $\ddot{y}(t)$ - Acceleration as a function of time
 U - Blast velocity
 $\hat{\delta}$ - Nondimensionalized Displacement
 Δ - Dimensionalized Displacement of the Plate
 Δt - Time step

- $\Delta \ddot{y}_i$ - Change in acceleration at beginning of time step
- Φ - Characteristic shape of displacement
- Φ_r - Characteristic shape of displacement for finite area
- π - PI (3.14159.....)
- σ - Dimensionalized Stress in the Plate
- $\hat{\sigma}$ - Nondimensionalized Stress in the Plate
- Σ - Summation
- ξ - Damping Ratio C/C_{cr}

Introduction

Numerous facilities are constructed throughout the world which potentially could be subjected to blast loads. This includes not only military facilities and embassies, but also structures erected near explosive sources and structures which are subject to terrorist attacks or other accidental explosions. There are numerous publications which cover the design of structures to resist various types of blast loads, but few are applicable to the design of the windows. This is rather amazing because one of the major causes of casualties from an explosion (after the initial overpressure) is from high velocity fragments, and broken glass falls into this category. (1)

Often heat-treated glass, which possesses greater resistance to uniform lateral loads than annealed glass, is used in structures which are intended to resist blast loads. While it is known that heat-treated glass is many times stronger than annealed glass, there are no well accepted design techniques for the use of heat-treated glass in blast situations. Most heat-treated glass design procedures presented in manufacturer's literature and building codes are based upon approaches which were intended to be used for the design of glass subjected to the effects of severe wind storms. In the case of severe wind storms, loads rarely exceed 200 psf and it is generally assumed

that design wind loads have a duration of 60 seconds. The magnitudes of blast loads can be much greater than 200 psf, and the duration of blast loads are generally much less than 60 seconds. Therefore, it is not proper to use existing glass design procedures for blast resistant glass design.

The results of this research provide a dynamic analysis which ultimately can be used for the design of blast resistant glass.

Research Plan

The purpose of this research is to develop a method to reduce the response of heat-treated glass subjected to blast loads to a single degree of freedom system which can be analyzed using a simple dynamic approach. A computer code designed to satisfy these requirements has been developed by the author and is presented in this paper as an acceptable method to ascertain the dynamic response of rectangular windows subjected to various blast loads. To demonstrate the accuracy of this method the results generated by the author's code, hereafter referred to as WINBLAST, are compared to the results of a detailed finite element analysis using ABAQUS (2), and actual test data compiled by the Waterways Experimentation Station in Vicksburg, Mississippi. (3)

Previous Research

Nonlinear Response of Rectangular Glass Plates

Glass plates commonly undergo deflections which are well in excess of their thickness prior to failure. When plate deflections exceed half of the plate thickness, a geometrically nonlinear plate analysis must be used to model the plate response. (4) When a plate experiences geometric nonlinear behavior, boundary conditions become significant in determining the response of the plate. Geometrically nonlinear plate analysis is highly complex. It is further complicated by the often unique nature of boundary restraints associated with window installations. For this reason the problem of glass plate analysis has not been well addressed in classical plate texts for static or dynamic response. (4)

Beason has shown through comparisons of experimental and analytical data that the case where the glass plate edges are simply supported and free to slip in-plane provides a reasonable design model. (4) These are the boundary conditions used in this report and WINBLAST.

Beason has used a modified version of a finite difference plate solution developed by Vallabhan and Wang (5) to produce a massive data base for the static performance of glass plates. These data are used by the author to establish assumed deflected shapes for various sized plates so that equivalent masses,

equivalent masses, forces, and stiffnesses can be developed for plate with aspect ratios between 0.2 and 5.0. This procedure will be explained in further detail after a review of the equivalent system response technique.

Blast Theory

The blast effects of an explosion create a shock wave composed of a high-pressure shock front which expands outward from the center of the detonation. The intensity of the pressure decreases with distance from the detonation point and time. (1) The shock front travels with a velocity, U , and obtains a peak overpressure, P , which results in a peak pressure, P' , on any structure in the blast's path. Figure 3-1 presents idealizations

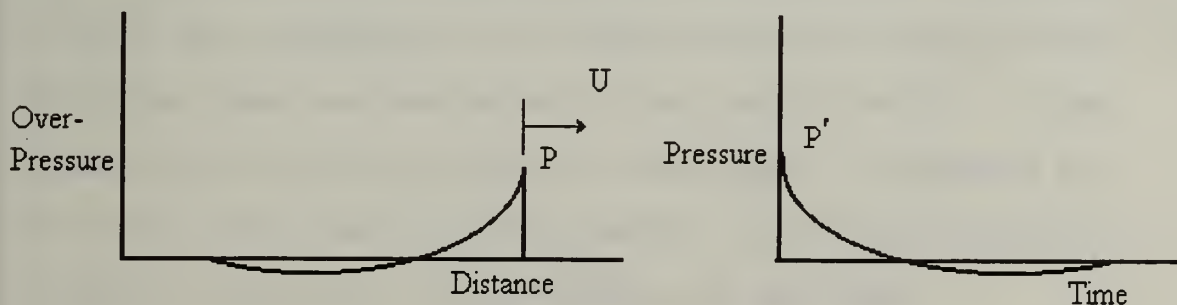


Figure 3-1. Blast Shapes

for the variation of blast pressures as a function of time and distance. (1)

When the shock front hits a window plate there is a diffraction effect as the plate reverses the direction of the

shock front and diverts the front around it. This results in the structure being subjected to a peak pressure which is larger than the peak overpressure. The overpressure results from an increase in air pressure immediately behind the shock front, while the peak blast pressure applied to structures in the blast's path includes the refraction effect discussed above. At the same time, air behind the shock front is moving away from the structure at a high velocity. This produces drag forces on the plate. (1) Detailed calculation procedures for estimating these pressures are presented in NAVFAC P-397 (1). For the purposes of this paper and WINBLAST, the magnitude of the peak blast pressure is assumed to be given.

Based on the above discussion, it can be seen that an explosion consists of much more than a simple high-impact load applied to the plate. While this is true, the effects of all but the diffraction and overpressure are generally considered to be minimal when compared to the diffraction and overpressure. (1) Therefore they are neglected in the current effort. The underlying principle is that if the plate is designed to withstand the blast's peak pressure, it should be able to withstand the other lesser effects of the blast.

Considering only the peak pressure, the forcing function, presented in Figure 3-1, can be idealized as a triangular load, as shown in Figure 3-2, where P' is the peak load experienced by the plate and T' is the duration of the idealized loading. For both the finite element analysis and WINBLAST a further

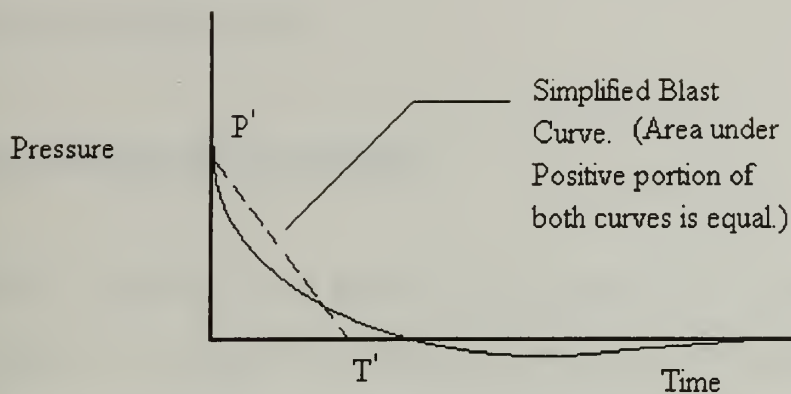


Figure 3-2. Simplified Blast Curve

modification to the simplified blast curve was made. As shown in Figure 3-3, the peak pressure has been offset by one millisecond to avoid the mathematical difficulty of the instantaneous acceleration which results from increasing the pressure on the plate from zero pounds per square inch to P' pounds per square inch over zero seconds. The area under the loading function presented in Figure 3-3 continues to be equal to the area under

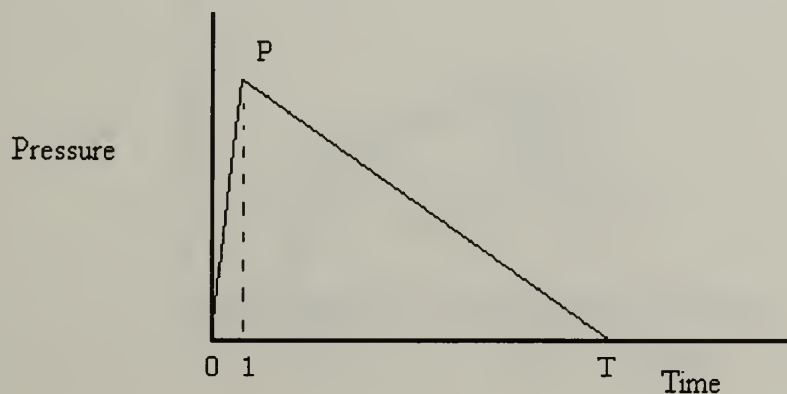


Figure 3-3. Modified Blast Curve

the positive pressure portion of the pressure-time relationship presented in Figure 3-2.

Linear Acceleration Method

A blast loading on a plate will result in a dynamic response of the plate. Perhaps the simplest method of dynamic analysis is the linear acceleration method which employs the basic equation of motion given in equation (1).

$$m\ddot{y} + c\dot{y} + ky = F(t) \quad (1)$$

where m = mass, c = damping, k = resistance, \ddot{y} = acceleration, \dot{y} = velocity, y = displacement, and $F(t)$ = force. The method assumes a linear acceleration during a fixed time interval, Δt , as shown graphically in Figure 3-4. (6) Letting t_i and t_{i+1} be, respectively, the designation for the time at the beginning and

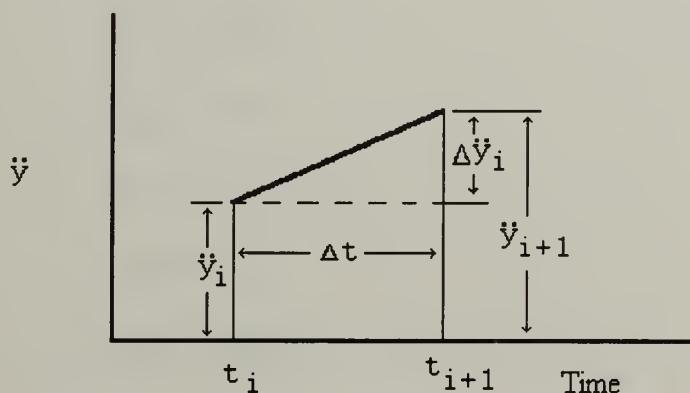


Figure 3-4. Linear acceleration during time interval

end of the time interval Δt , the acceleration, $\ddot{y}(t)$, can be expressed numerically as:

$$\ddot{y}(t) = \ddot{y}_i + (\Delta\ddot{y}_i/\Delta t)(t - t_i) \quad (2)$$

where $\ddot{y}(t)$ represents the acceleration at any time t , \ddot{y}_i represents the acceleration at the beginning of the time interval, and $\Delta\ddot{y}_i$ represents the change in acceleration over the interval.

Integrating equation (2) twice to obtain an expression for displacement, $y(t)$, gives:

$$y(t) = y_i + \dot{y}_i(t-t_i) + \ddot{y}_i(t-t_i)^2/2 + (\Delta\ddot{y}_i/\Delta t)(t-t_i)^3/6 \quad (3)$$

Further manipulation of equations (1), (2), and (3) results in the condensed equation:

$$(a_0m + a_1c + k)y_{i+1} = F_{i+1} + m(a_0y_i + a_2\dot{y}_i + a_3\ddot{y}_i) + c(a_1y_i + a_4\dot{y}_i + a_5\ddot{y}_i) \quad (4)$$

Where,

$$a_0 = 6/\Delta t^2 \quad (5)$$

$$a_1 = 3/\Delta t \quad (6)$$

$$a_2 = 6/\Delta t \quad (7)$$

$$a_3 = 2 \quad (8)$$

$$a_4 = 2 \quad (9)$$

$$a_5 = \Delta t/2 \quad (10)$$

Complete formulation of this method can be found in Paz. (6) With the above expressions, displacements can now be numerically

calculated once a time step, Δt , is chosen. Δt must be chosen such that the variation of deflection over the time step is small. If the chosen time step is too large then the solution will not converge to the steady-state vibrations. For WINBLAST and ABAQUS analysis a Δt of 0.0001 seconds was used.

Approximate Equivalent System

Biggs has presented a method to reduce an infinite degree of freedom system to a single degree of freedom system having the parameters of F_e (Force Equivalent), m_e (Mass Equivalent), and k_e (Spring Equivalent). (7) This method was first introduced in an Army Corps of Engineers Manual as a simplified method to determine responses of structural members subjected to atomic blasts. (8) The basis of this method is to reduce the system to an equivalent one degree of freedom system, as shown in Figure 3-5. Figure 3-5 (a) shows a fixed beam along with its corresponding equivalent one degree of freedom system. Figure 3-5 (b) and (c) show similar conversions for a frame structure and a plate respectively.

In order to develop the equivalent systems, a characteristic shape (Φ) of the lateral deflection must be known. The characteristic deflected shape, Φ , is a function which allows the deflection at any given point to be related to the deflection at any other point. To define Φ using a discrete idealization,

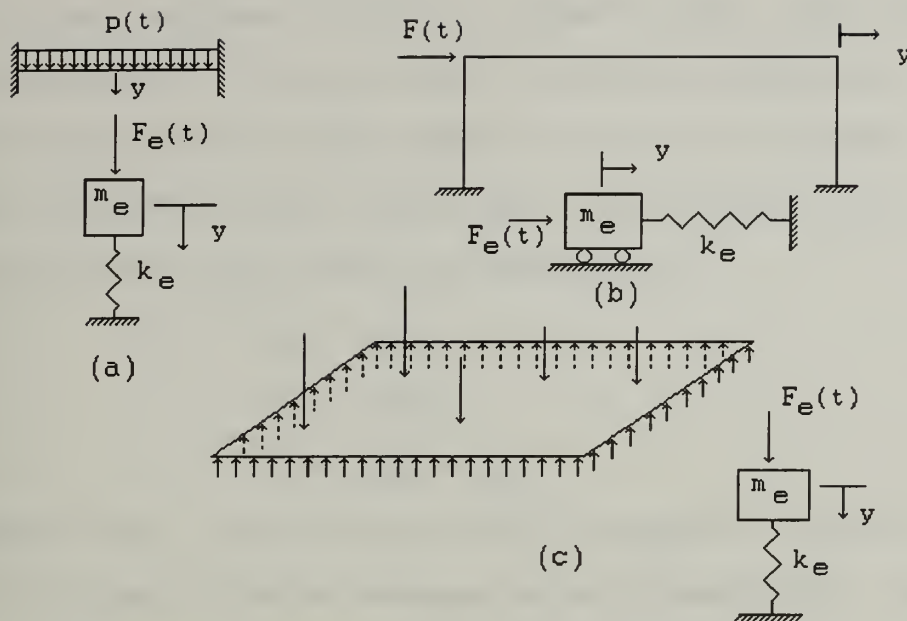


Figure 3-5. Equivalent one-degree systems.
(a) Fixed Beam, (b) Frame, (c) Plate

the structural member in question is divided into a number of discrete segments. Each segments' deflection is then divided by the deflection at the base point. The base point is usually associated with the maximum deflection of the member. The resulting values become the Φ values used in equations (11) and (12).

$$m_e = \sum M_r \Phi_r^2 \quad (11)$$

$$F_e = \sum F_r \Phi_r \quad (12)$$

where n is the total number of discrete segments, M_r is the mass of the discrete segment, and F_r is the force applied to the discrete segment.

Equations (11) and (12), presented in Biggs (7), are simplified expressions derived from the Corps of Engineers formulation which relates the total strain energies of the actual

and equivalent systems. They are based on the requirement that the displacement of the equivalent system be identical to the maximum displacement of the actual system at all times. (8) WINBLAST utilizes a mass factor (K_M), load factor (K_L), and resistance factor (K_R) which are defined as:

$$K_M = m_e/m_t \quad (13)$$

$$K_L = F_e/F_t \quad (14)$$

$$K_R = k_e/k = K_L \quad (15)$$

Unlike Biggs, the factors used in WINBLAST vary as a function of load duration because of nonlinearities. Therefore, multiple equivalency factors need to be developed. These values vary as the plate deflects further into the nonlinear zone.

Once these equivalency factors are established they can be substituted into equation (1) to obtain:

$$K_M m y + c y + K_L k y = K_L F(t) \quad (16)$$

or,

$$m_e y + c y + k_e y = F_e(t) \quad (17)$$

The multi-degree of freedom system is now reduced to a single degree of freedom system whose response can be described by equation (17). It must be noted that the magnitudes of the equivalency factors in equation (17) are all functions of displacement. The displacements at any point in time can be determined by utilizing the linear acceleration method to solve equation (4) numerically.

Formulation of Method

The procedure used by WINBLAST is to first convert the infinite degree of freedom glass plate system into an equivalent one degree of freedom system as proposed by Biggs and the Army. (7,8) Once this is accomplished, WINBLAST applies a linear acceleration analysis to determine the response of the plate in question.

In order to utilize this procedure, the characteristic deflected shape must be known. To determine the characteristic shape for glass plates, Beason utilized a modified version of a finite difference plate solution developed by Vallabhan and Wang (5) to determine the static deflections at 600 discrete point in various rectangular glass plates. Next, each deflection value was divided by the maximum deflection of the plate, in effect normalizing the deflections. In this way the deflection at any given point is related to the maximum deflection. Thus a characteristic shape is now defined by these 600 "normalized" deflections. This method of using static deflections to establish a characteristic shape was suggested by Biggs. (7) The author, of this paper, then used these normalized Φ values in equations (11) and (12) to calculate m_e and F_e . Once these values are determined the equivalent factors can be easily calculated using equations (13), (14), and (15).

This procedure was repeated numerous times to generate the equivalent factors for twenty-one nondimensionalized rectangular glass plates with aspect ratios between 1.0 and 5.0 with a 0.2 increment. Thirty one sets of equivalent factors were generated for each aspect ratio to fully describe the changing characteristic shape of the glass plate nonlinear geometries. Appendix E presents a tabulation of the equivalent factors for all aspect ratios considered in this report. Figure 4-1 shows the nonlinear relationship between the peak deflections and applied load on a square plate. Figures 4-2 and 4-3 show the relationship between the equivalent values and the non-dimensionalized loads for square glass plates.

The only remaining value which must be calculated before applying the linear acceleration method is the resistance in the plate. This resistance, or "spring constant", is only constant in the linear zone. As the plate deflections increase past the linear zone the resistance increases nonlinearly. But, with the help of Figure 4-1 or the information in Appendix E, which presents deflections versus applied forces, the spring constant can easily be obtained by dividing the applied force by the resulting deflection. The values obtained by this simple load-over-deflection calculation represent the average plate resistance over the particular interval in question. Figure 4-4 shows the spring constant values as a function of displacement for a 40" x 40" square plate, 0.71" thick.

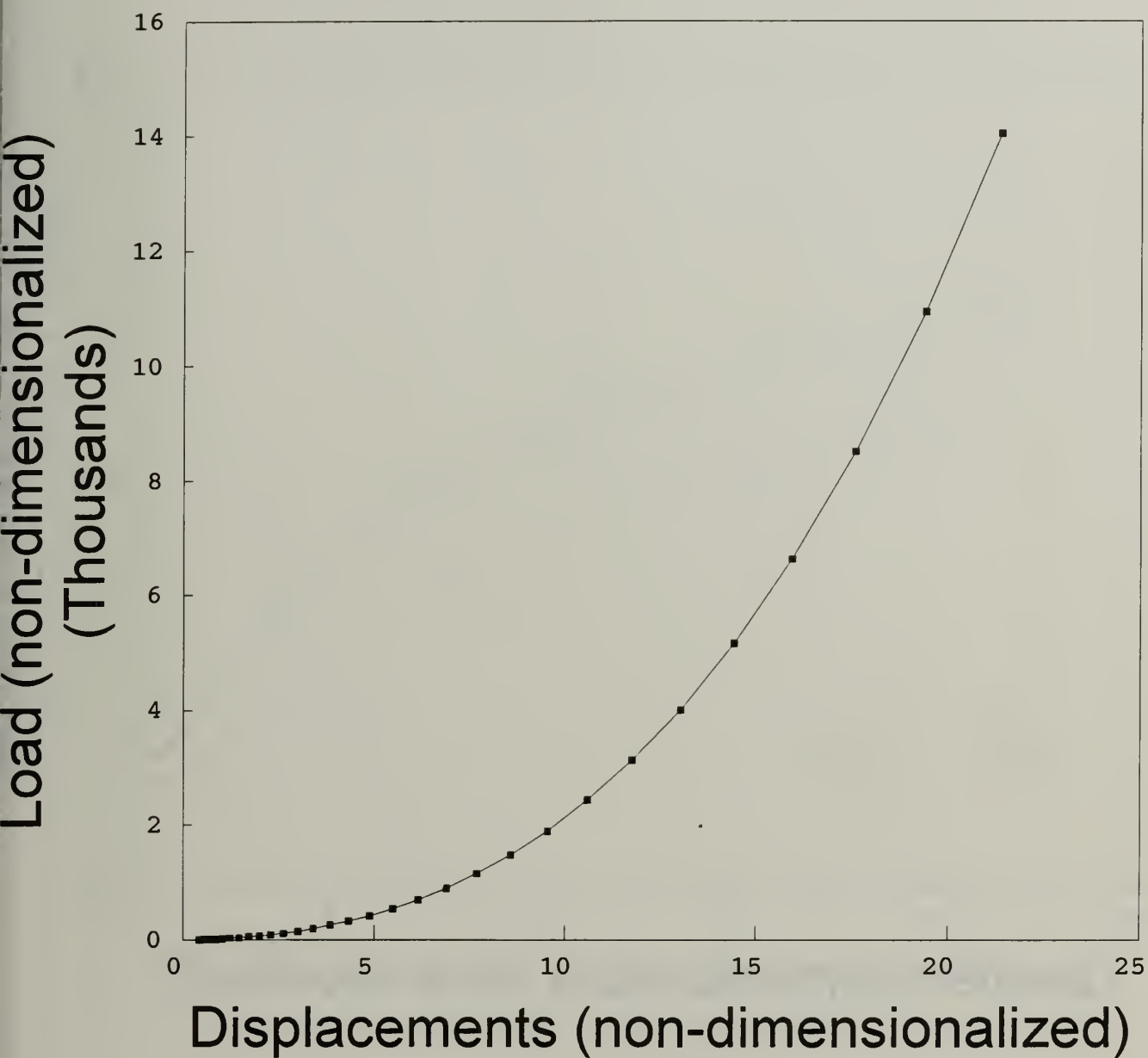


Figure 4-1. Displacements -vs- Load (Square Glass Plates)

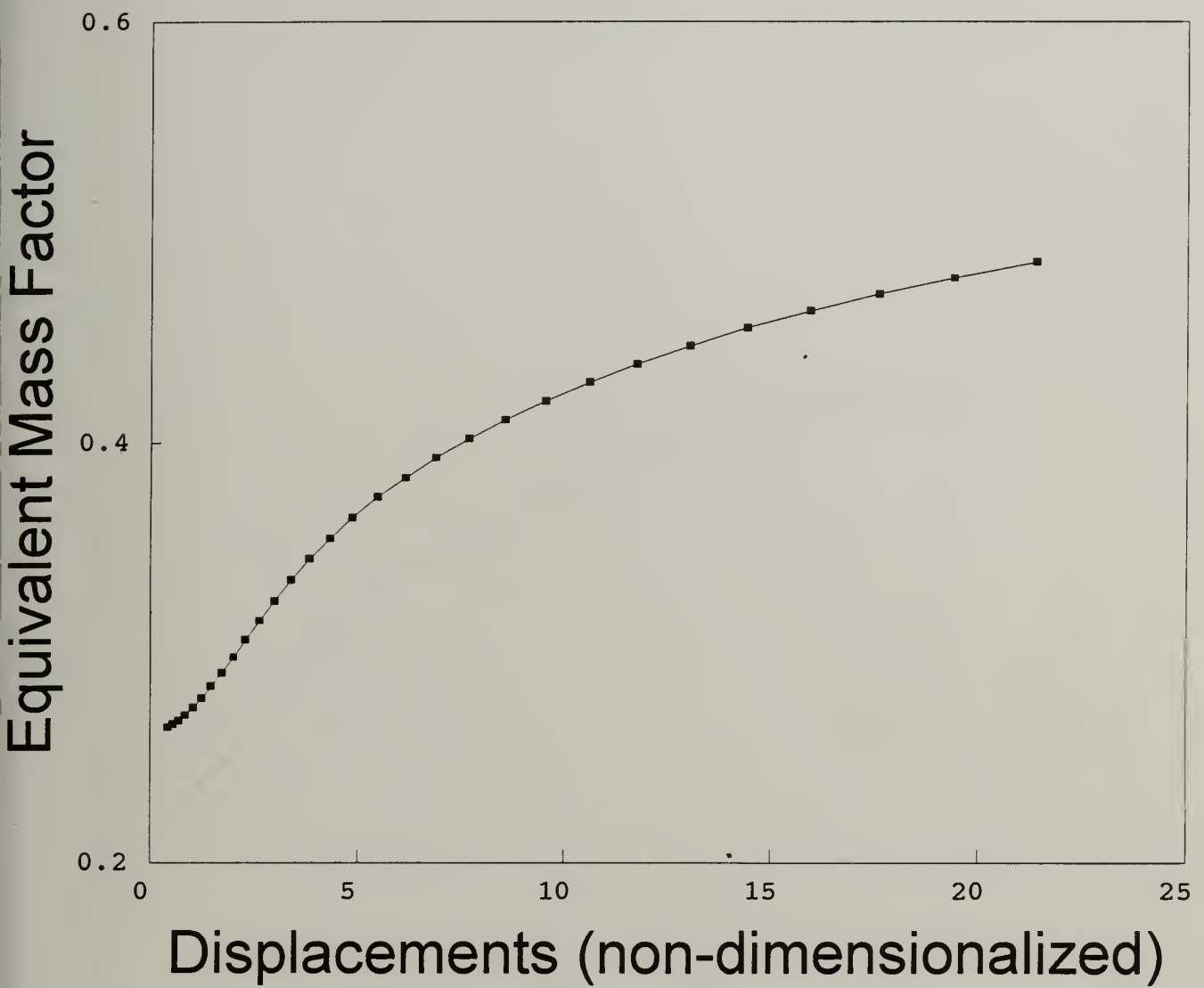


Figure 4-2. Equivalent Mass Factor (Square Glass Plates)

Equivalent Load Factor

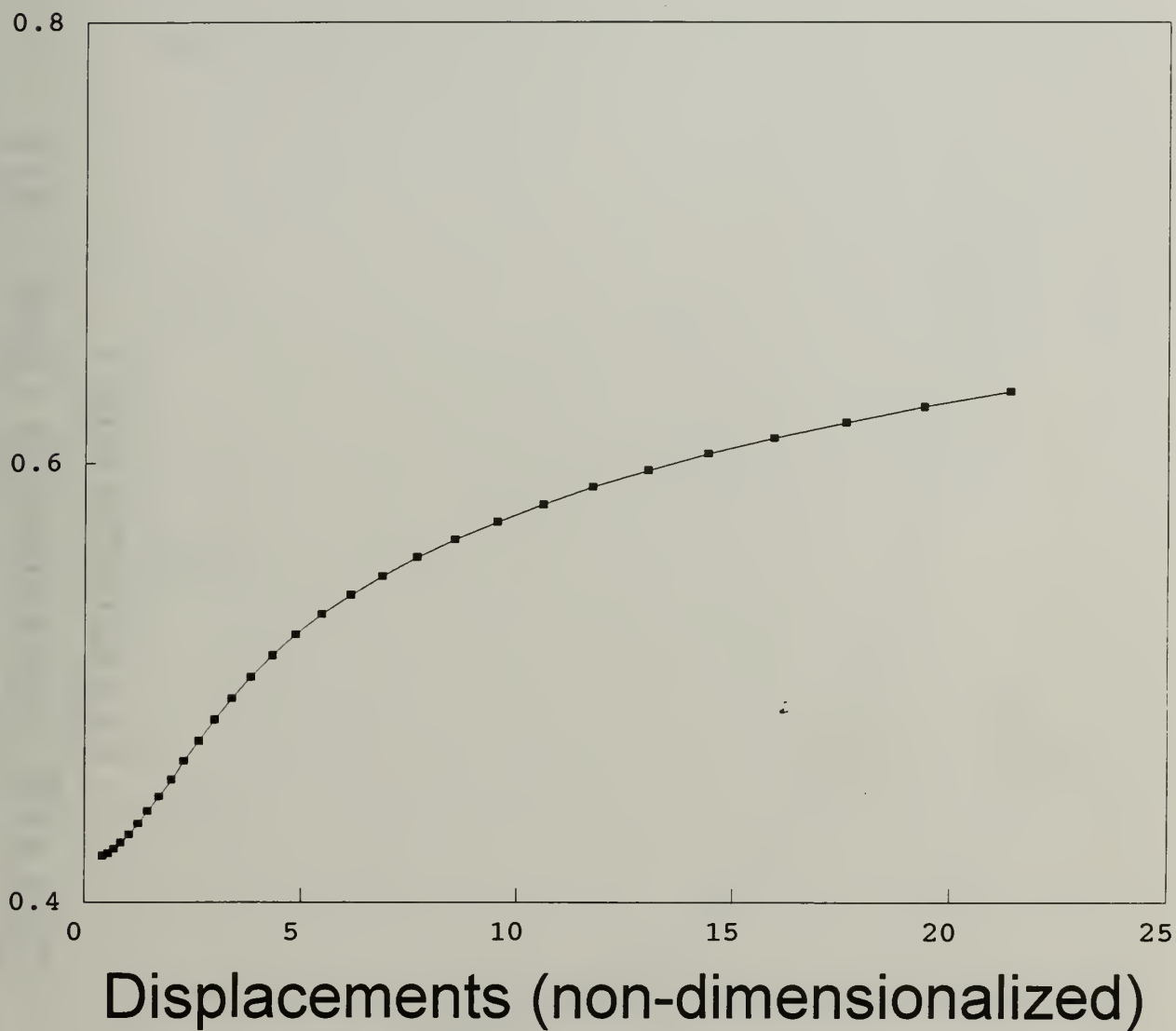


Figure 4-3. Equivalent Load Factor (Square Glass Plates)

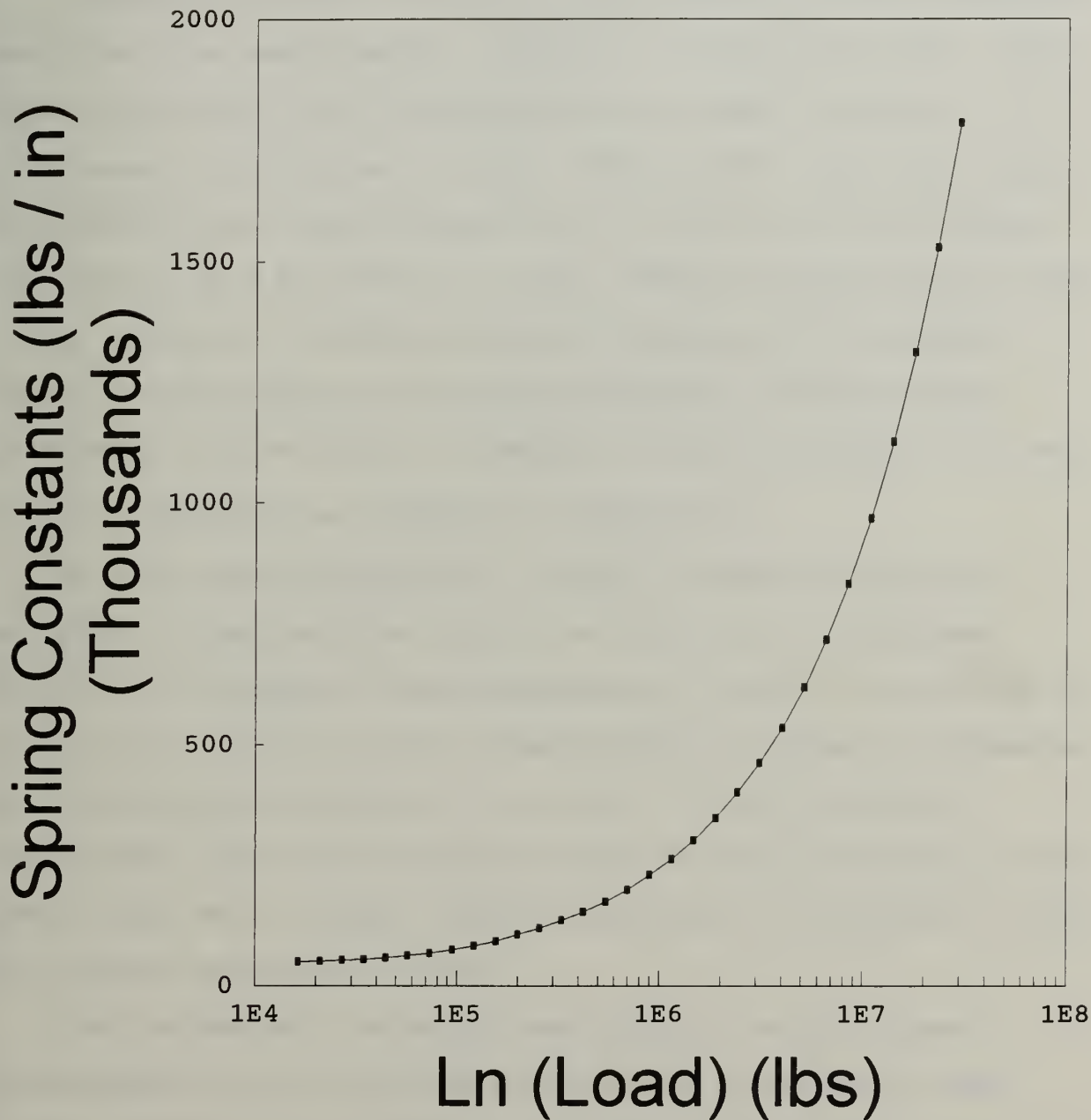


Figure 4-4. Spring Constant -vs- Load for a 40" x 40" Window

Having compiled the master data set (Appendix E) and being able to calculate plate resistance, WINBLAST can now enter into its dynamic analysis and determine the deflections for any uniform loading on any rectangular plate.

WINBLAST requires the input of the window size and thickness and blast size and duration, damping is an optional item. Total dynamic analysis time is also input as an output control. It then reads in the values of load, displacement, equivalent mass, equivalent force, and stresses from the master data and stores the data in 31 x 21 matrices. Next, WINBLAST dimensionalizes the loads, stresses, and displacements, calculates the constants needed for the linear acceleration analysis, and the spring constants. A flow chart of WINBLAST is given in Figure 4-5, and a copy of the code is presented in Appendix A.

At this point the program is ready to begin the dynamic analysis. First the load applied to the plate is calculated based on the standard blast approximation function illustrated in Figure 3-3, then the current displacement is checked to determine which equivalent values are to be used. If the calculated displacement does not correspond to any of the data points in the master data set, a simple linear interpolation is applied to find the correct equivalency values.

The incremental changes in acceleration, velocity, and displacement are now calculated and added to the stored total values. Every ten increments (or every millisecond) the data are printed out.

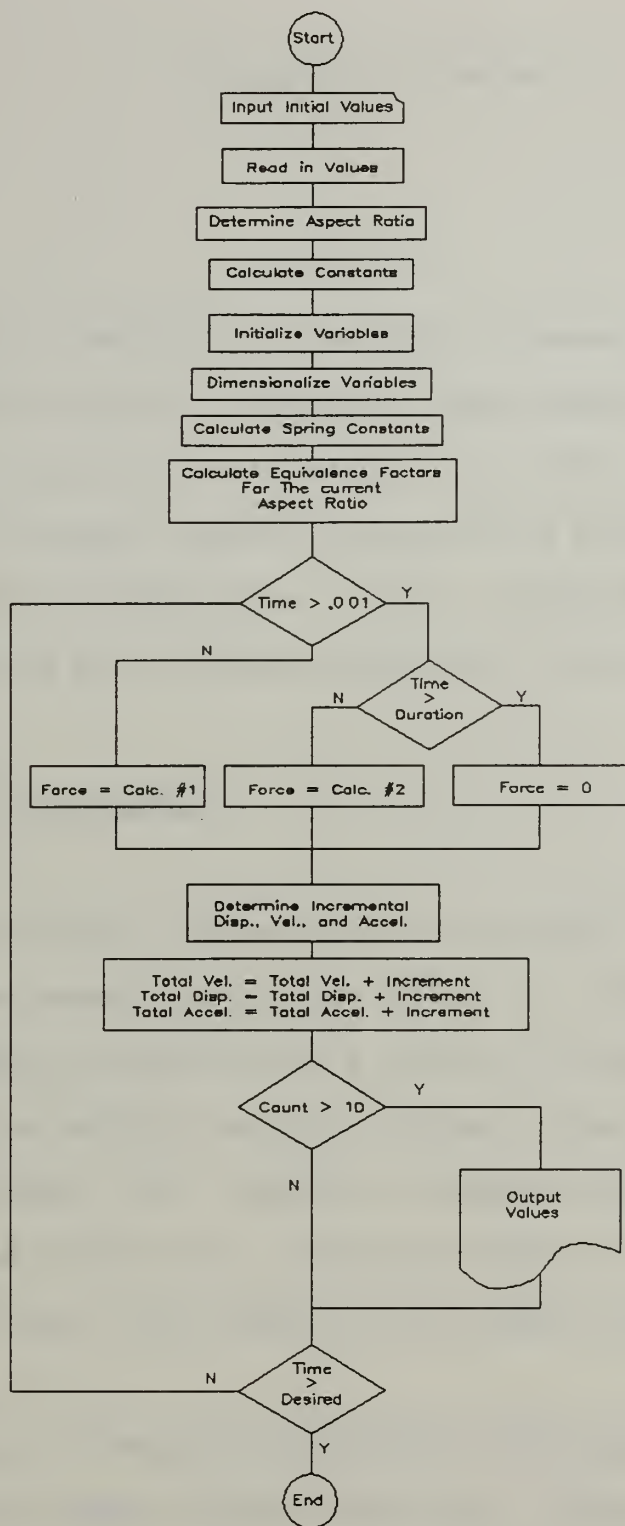


Figure 4-5. Flowchart for WINBLAST

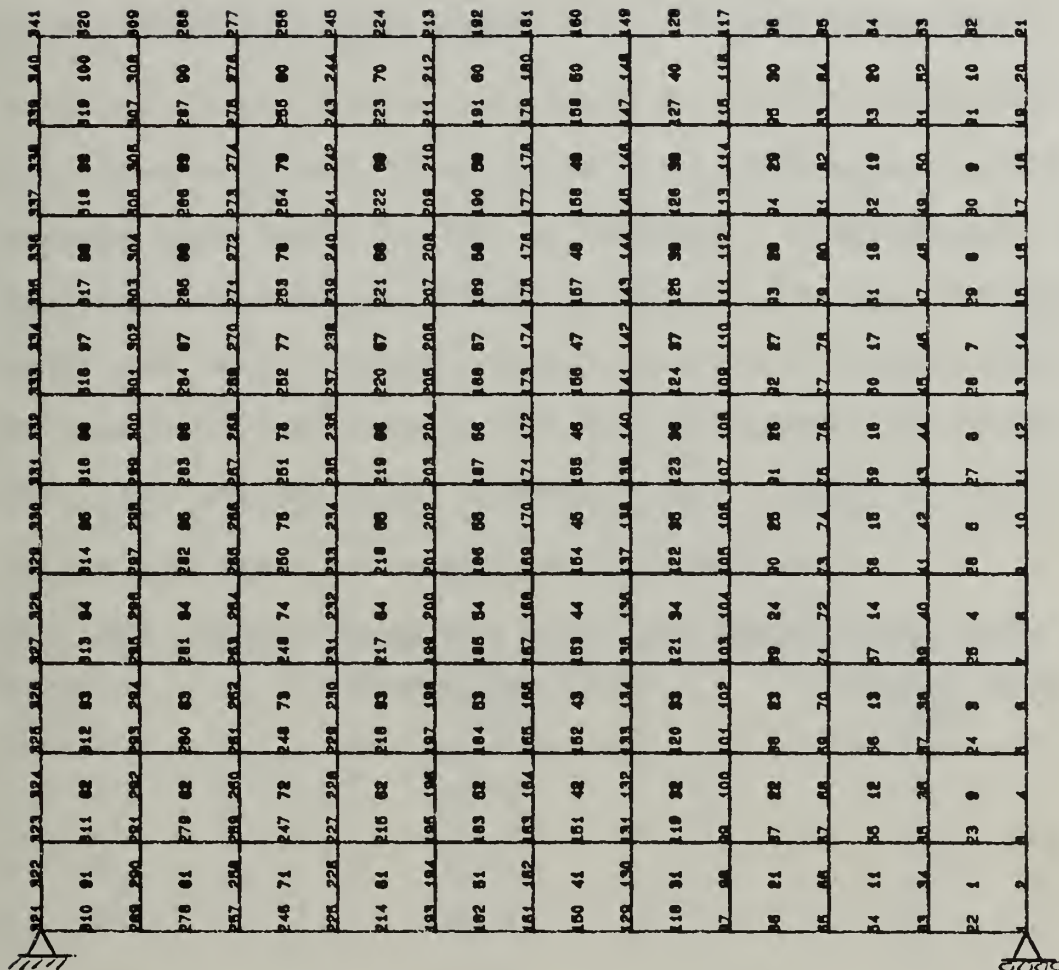
Evaluation of Method

To validate WINBLAST, it is first compared to the finite element computer results generated using ABAQUS. (2) This program was used in conjunction with PATRAN (9) (also a computer application) to model window plates as 100 element meshes. Then the results from WINBLAST are further compared to experimental data compiled by the Waterways Experiment Station. (3)

WINBLAST -vs- ABAQUS

ABAQUS was used to model the glass window plates as 100 element meshes using the element S8R5. (2) This element is an eight-noded shell element with a reduced 5-node integration feature. It is perhaps the most commonly used shell element in the ABAQUS library. (2) Figure 5-1 shows a graphical model, produced using PATRAN (9), of the mesh used in analysis. A sample of the input code used for the ABAQUS analysis is located in Appendix B.

The boundary conditions previously discussed were input by fixing all the edges in the z-direction, fixing one corner from displacements in all directions, and preventing y-direction displacement of the adjacent corner (see Figure 5-1). The load was applied as shown in Figure 3-3, and maximum displacements



Note: Plate fixed against Z-direction deflection along all edges.

Figure 5-1. Finite Element Model



versus time was output. The duration of the loads was chosen as 26 milliseconds. This duration corresponds to the calculated duration of similar loads used in the experimental data. (3) No damping is included in this ABAQUS -vs- WINBLAST comparison.

A total of 11 windows were analyzed to validate WINBLAST. The first three windows correspond to the window sizes tested by the Waterways Experiment Station in Vicksburg, Mississippi. The remaining eight windows are chosen to demonstrate the versatility of WINBLAST, as they represent larger plates and larger loads. Thus they serve as verification for various aspect ratios and loads well into the nonlinear response zone. Table 5-1 shows the window sizes analyzed for comparison with ABAQUS.

Table 5-1. Window Sizes and Loads for ABAQUS Comparison

| Window Size (in) ----- | Window Thickness (in) ----- | Applied Load (psi) ----- |
|------------------------------|-----------------------------------|--------------------------------|
| 26 x 26 | 0.71 | 14.6 |
| 36 x 36 | 0.71 | 14.6 |
| 40 x 40 | 0.71 | 14.6 |
| 72 x 72 | 1.06 | 14.6 |
| 72 x 72 | 1.06 | 30.0 |
| 72 x 72 | 1.06 | 40.0 |
| 72 x 72 | 1.06 | 50.0 |
| 72 x 24 | 0.71 | 75.0 |
| 72 x 24 | 0.71 | 14.6 |
| 32 x 20 | 0.71 | 14.6 |
| 27 x 20 | 0.71 | 14.6 |

Table 5-2 presents a comprehensive comparison of the peak deflections predicted by WINBLAST and ABAQUS showing the total differences in deflections both in total inches and as a percentage of the WINBLAST output.

Table 5-2. ABAQUS -vs- WINBLAST Peak Deflections

| Window Size (in) | Thick- ness (in) | Load (psi) | ABAQUS Deflection (in) | WINBLAST Deflection (in) | Diff. (in) | Diff. (%) |
|------------------------|------------------------|---------------|------------------------------|--------------------------------|---------------|--------------|
| ----- | ----- | ----- | ----- | ----- | ----- | ----- |
| 26 x 26 | 0.71 | 14.6 | 0.1599 | 0.1500 | -0.0099 | -6.6 |
| 36 x 36 | 0.71 | 14.6 | 0.5417 | 0.5307 | -0.011 | -1.9 |
| 40 x 40 | 0.71 | 14.6 | 0.7706 | 0.7603 | -0.0103 | -1.4 |
| 72 x 72 | 1.06 | 14.6 | 1.888 | 1.8751 | -0.0129 | -0.7 |
| 72 x 72 | 1.06 | 30.0 | 3.003 | 3.0464 | 0.0434 | 1.5 |
| 72 x 72 | 1.06 | 40.0 | 3.535 | 3.6208 | 0.0858 | 2.4 |
| 72 x 72 | 1.06 | 50.0 | 3.991 | 4.1127 | 0.1217 | 3.1 |
| 72 x 24 | 0.71 | 14.6 | 0.3749 | 0.3390 | -0.0359 | 10.6 |
| 72 x 24 | 0.71 | 75.0 | 1.776 | 1.6867 | -0.0893 | -5.3 |
| 32 x 20 | 0.71 | 14.6 | 0.1143 | 0.1093 | -0.005 | -4.6 |
| 27 x 20 | 0.71 | 14.6 | 0.09266 | 0.0867 | -0.006 | -6.9 |

Table 5-2 shows a very close relationship between WINBLAST's one-degree of freedom model and a detailed multi- degree of freedom finite element model. WINBLAST is off by the largest percentage (although a minute total distance) when the window deflections are small and the plate remains linear. However, as

the deflections (and failure probability) increase, so does the accuracy of WINBLAST.

The complete data generated from WINBLAST for the 72" x 72" window subjected to the 14.6 psi load can be found in Appendix C, along with all the other WINBLAST results. In addition, the results are presented graphically on the following pages in Figure 5-2 (Displacements), Figure 5-3 (Velocities), Figure 5-4 (Accelerations), and Figure 5-5 (Stresses). Figure 5-6 shows a graphical comparison of deflections between WINBLAST and the finite element analysis, ABAQUS. The two solutions are nearly identical. These results verify the dynamic analysis from a theoretical standpoint. All output generated by ABAQUS is located in Appendix D.

WINBLAST -vs- Experimental Data

The purpose of this section is to compare WINBLAST's output with experimental data. Table 5-3 shows the window sizes tested by the Waterways Experiment Station. (3) The thicknesses shown in Table 5-3 correspond to the average measured thicknesses of the windows.

Previous results were generated assuming no damping. However, real windows are damped and therefore damping has now been included in the peak deflections generated by WINBLAST and presented in Table 5-4.

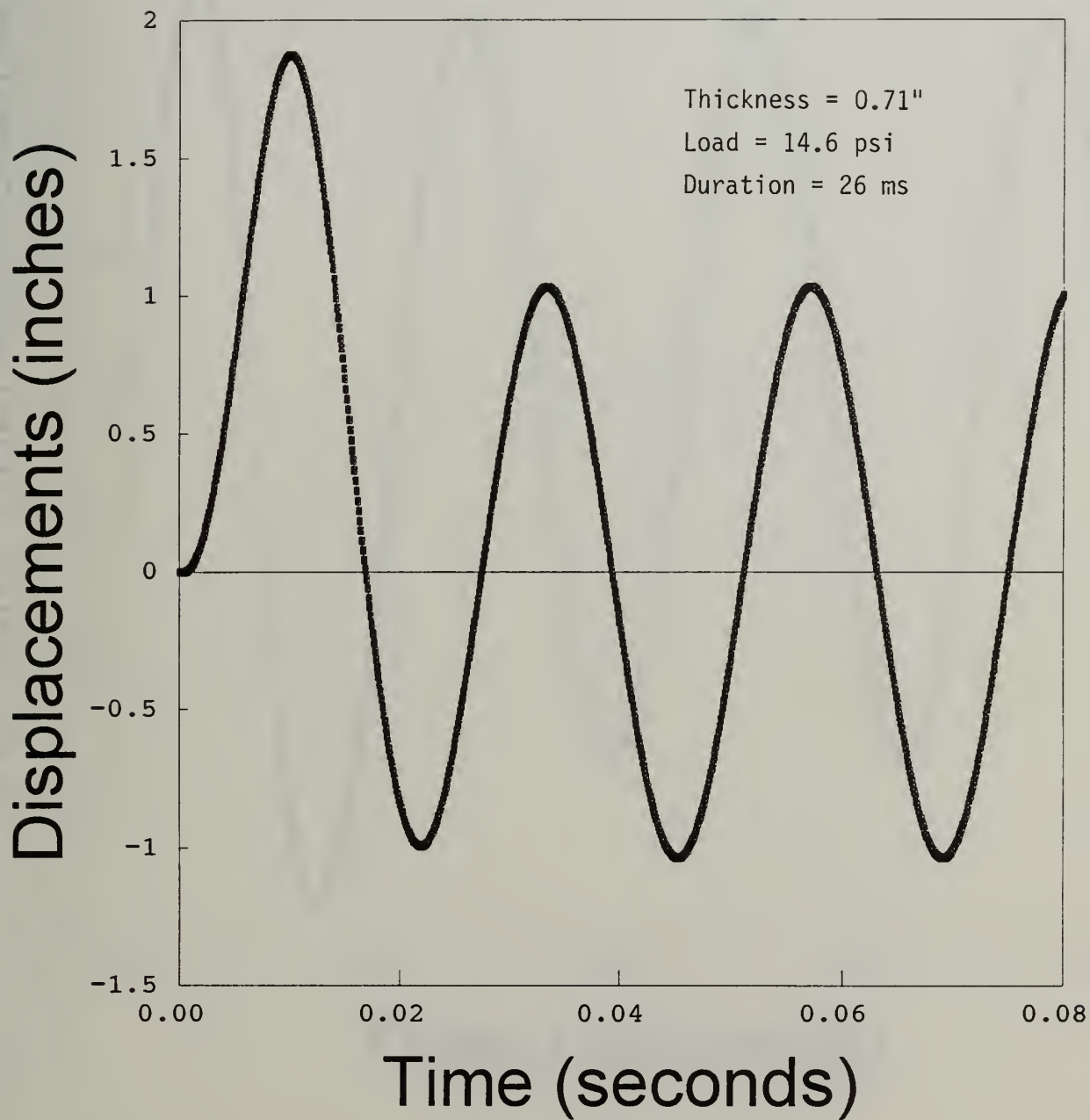


Figure 5-2. Displacements of a 72" x 72" Window Plate

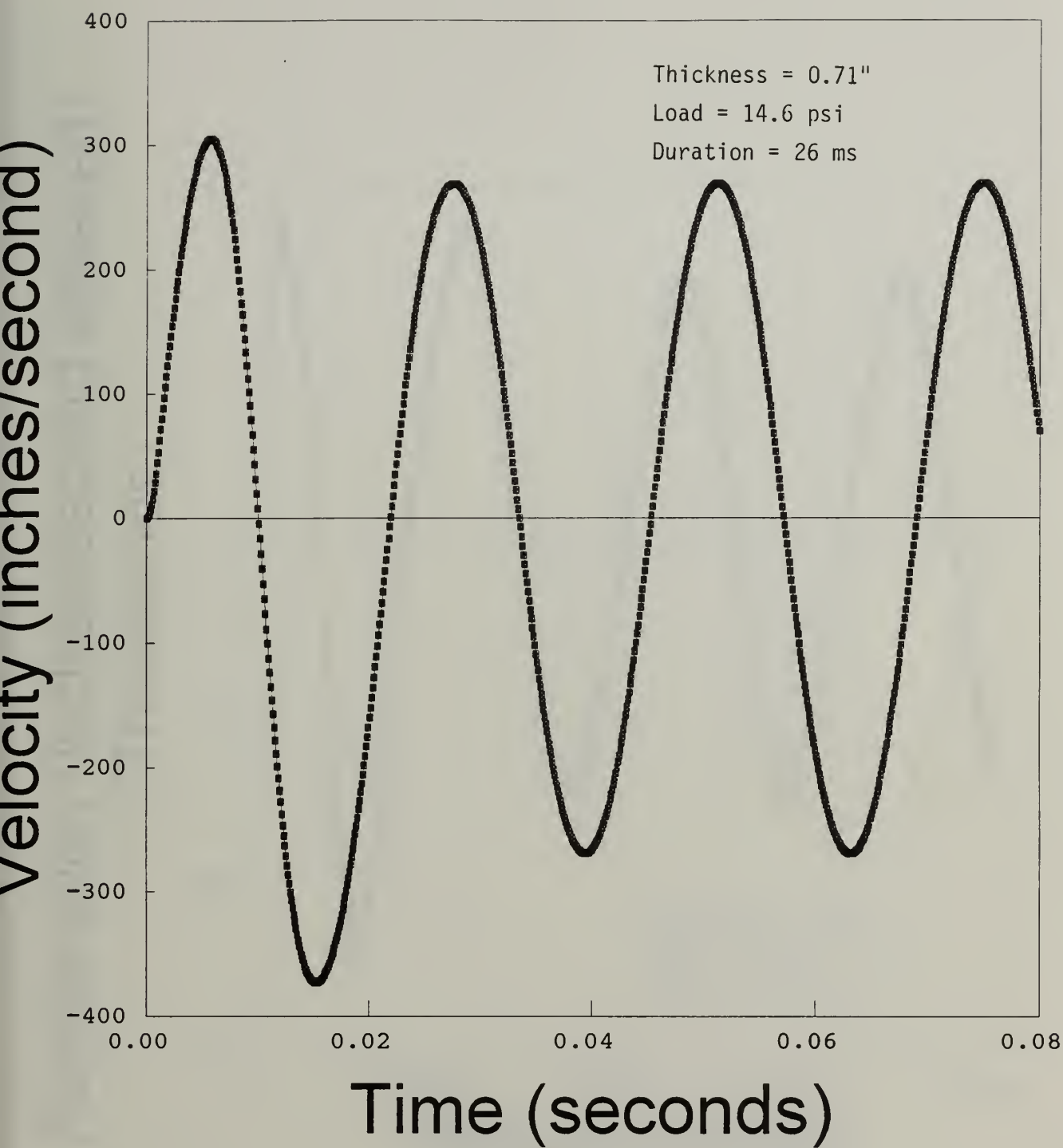


Figure 5-3. Velocity of a 72" x 72" Window Plate

Acceleration (inches/second squared)
(Thousands)

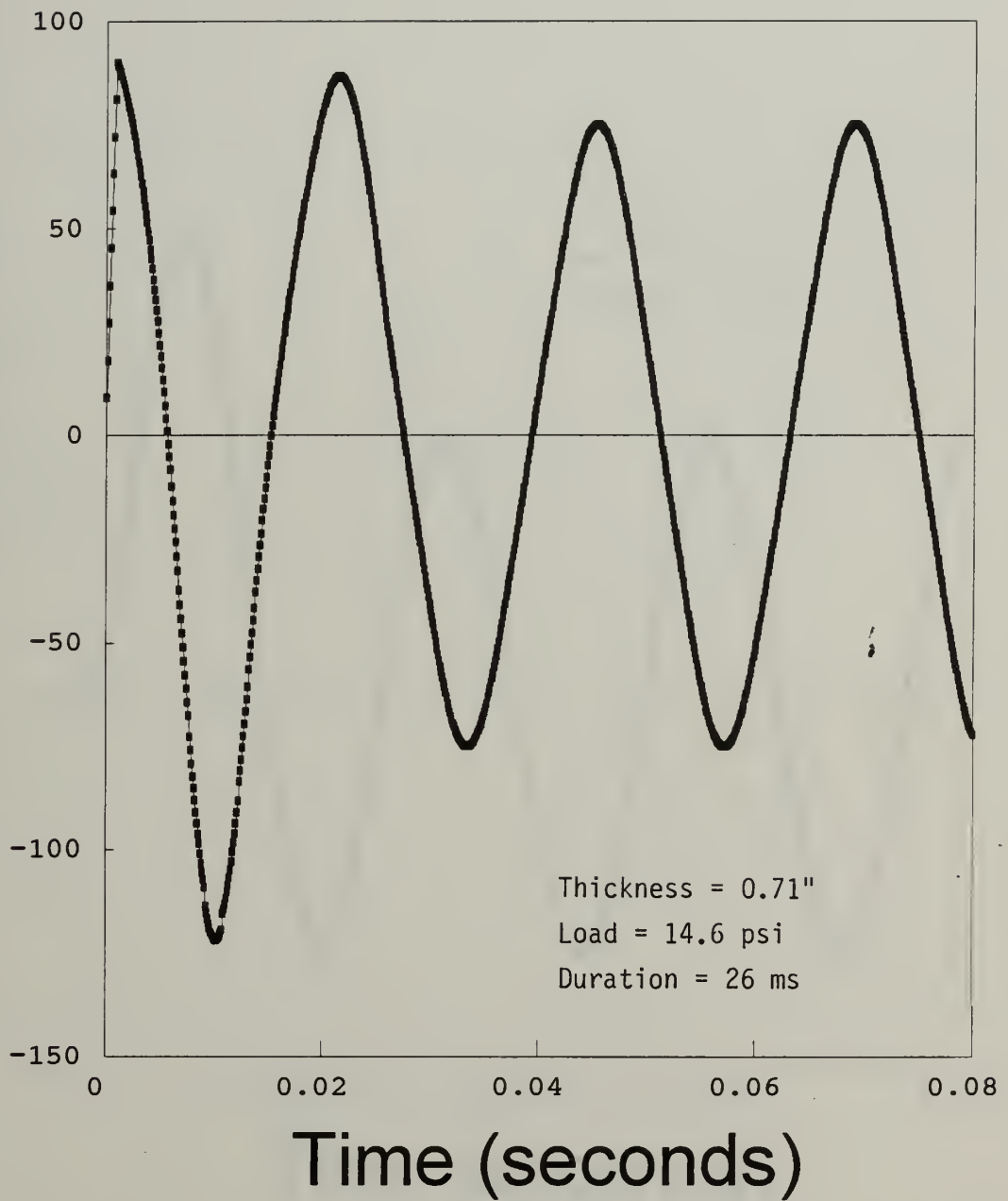


Figure 5-4. Accelerations of a 72" x 72" Window Plate

Stress (pounds/inches squared)
(Thousands)

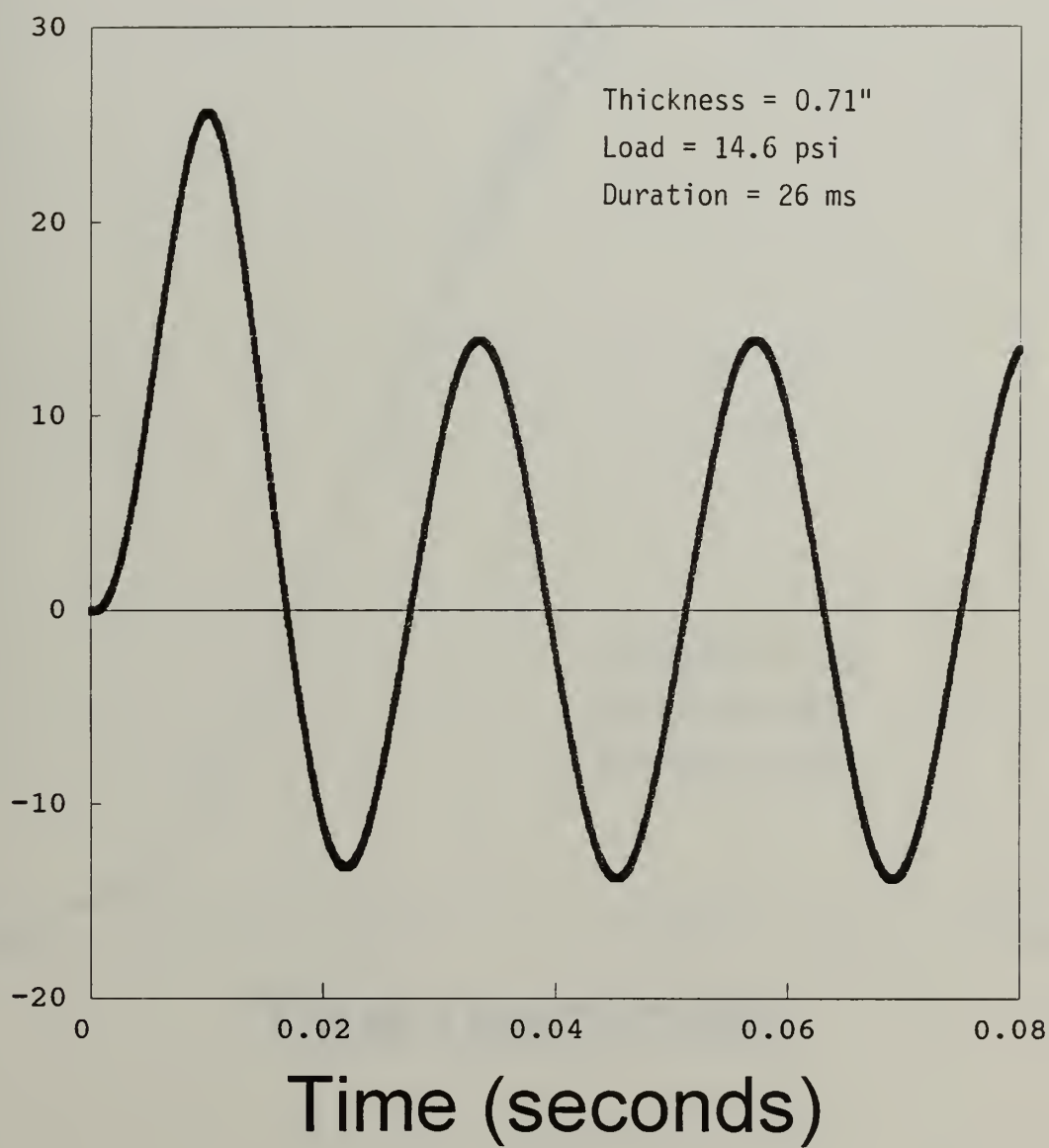
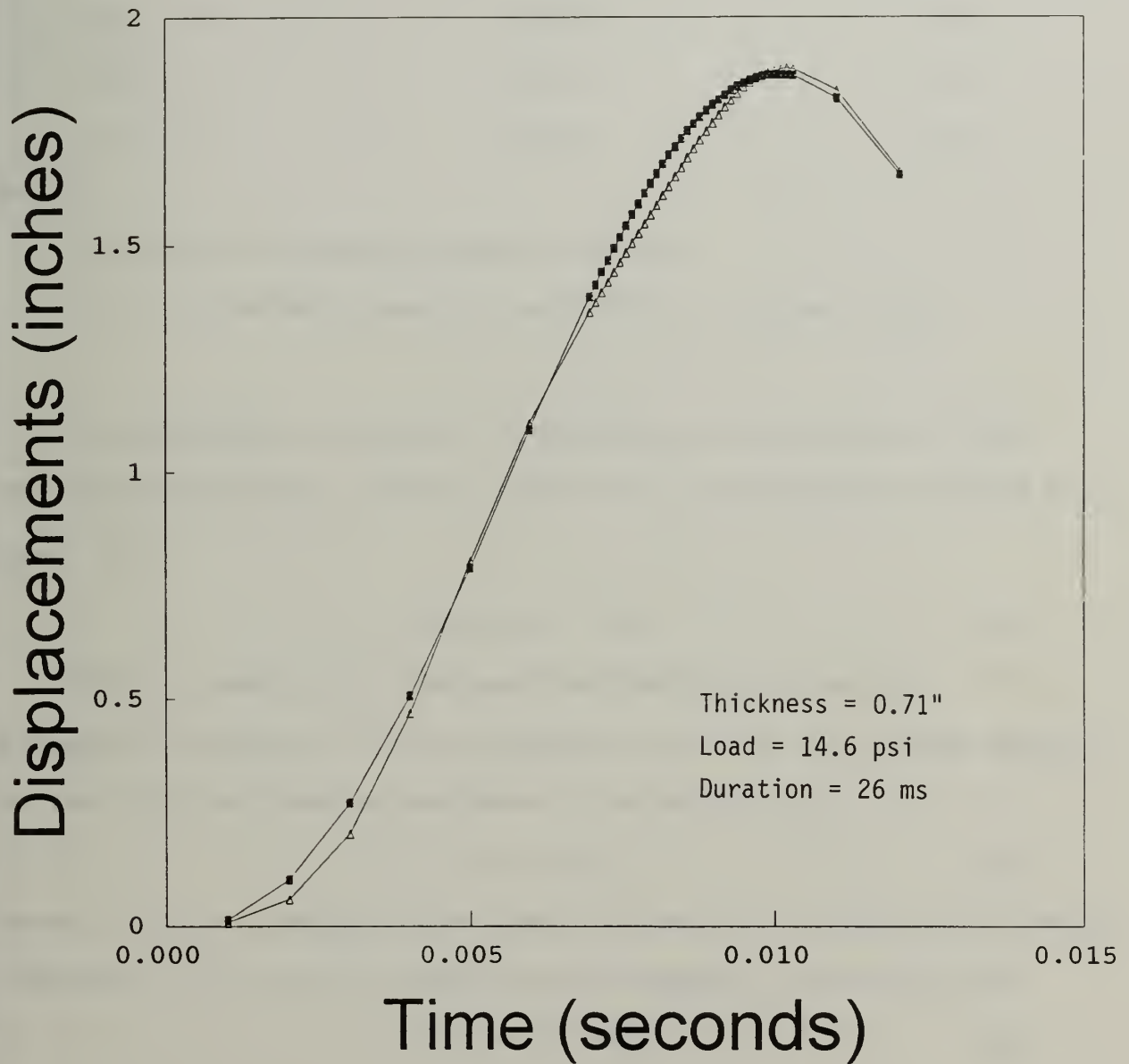


Figure 5-5. Stresses of a 72" x 72" Window Plate



—■— WINBLAST —▲— ABAQUS

Figure 5-6. WINBLAST -vs- ABAQUS for a 72" x 72" Window Plate

Table 5-3. Waterways Experiment Station Test Windows

| Window Size (in) ----- | Window Thickness ^a (in) ----- | Applied Load ^b (psi) ----- |
|------------------------------|--|---|
| 26 x 26 | 0.819 | 14.6 |
| 26 x 26 | 0.783 | 14.6 |
| 36 x 36 | 0.813 | 14.6 |
| 36 x 36 | 0.806 | 14.6 |
| 40 x 40 | 0.808 | 14.6 |

Notes:

(a) Overall average window thickness

(b) Calculated pressure load based on applied blast

To determine the amount of damping in the windows of the Waterways Experiment Station report the log decrement method was used. (6)

$$\ln(y_0/y_1) = 2\pi\xi \quad (18)$$

Where y_0 and y_1 are the peak deflections of any two successive peaks and ξ is the damping ratio of the system damping to the critical damping as shown in equation (19):

$$\xi = C/C_{cr} \quad (19)$$

where C is the damping value used in the basic equation of motion (equation (1)) and C_{cr} (the critical damping) is defined as:

$$C_{cr} = 2 (\sqrt{km}) \quad (20)$$

or,

$$C_{cr} = 2 (\sqrt{k_e m_e}) \quad (21)$$

for our equivalent system.

Figure 5-7 shows a the log decrement method graphically.

A complete derivation and analysis of the log decrement method is presented in Paz. (6)

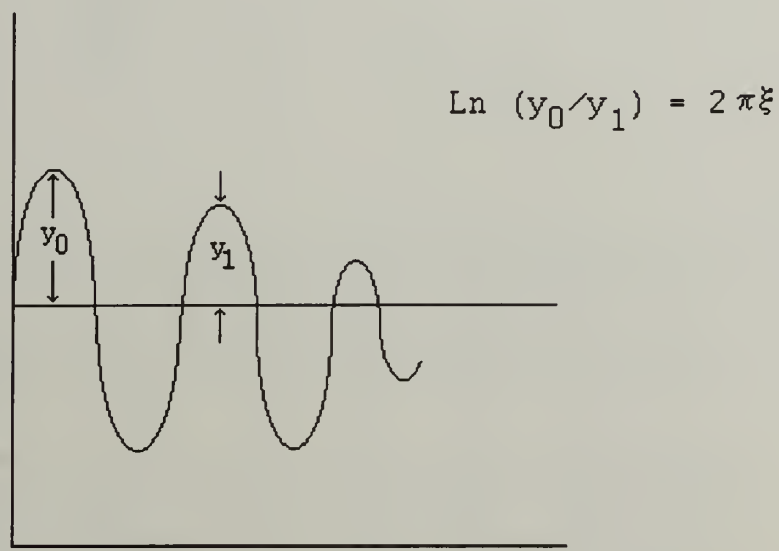


Figure 5-7. Graphical Log Decrement Method

The Waterways Experiment Station Report (3) included graphic plots of the measured deflections versus time. These were used to calculate the damping in the window systems used. Figure 5-8 presents a sample plot taken from the report. Using the log decrement method on Figure 5-8 and the other figures in the Waterways Experiment Station Report, the average damping value was approximately 4% so Table 5-4 includes 4% damping.

Gage
Size: 200050
Pass 20000. HZ
3.6
ion -1863

NCEL-1 DEF-8
TDR 7
SMD
500 KHZ 3-OCT-91

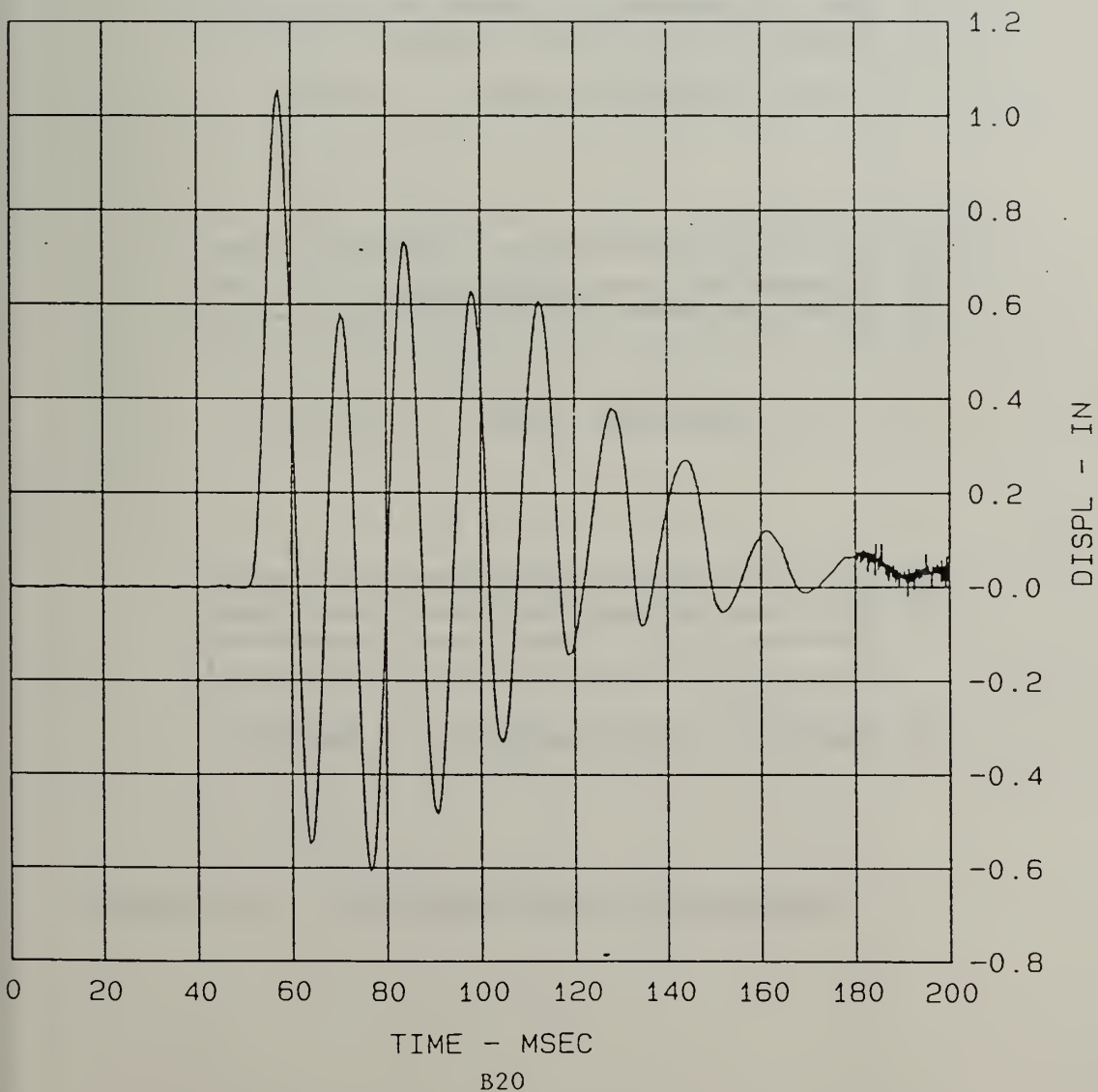
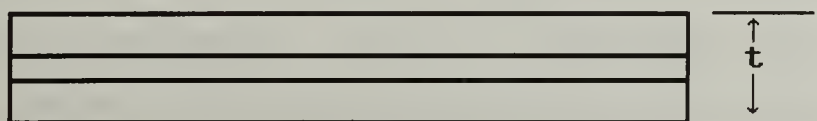
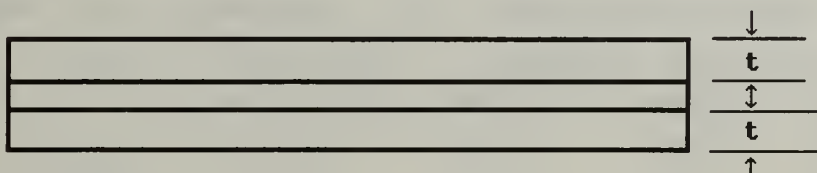


Figure 5-8. Sample Graphical Output of Experimental Data

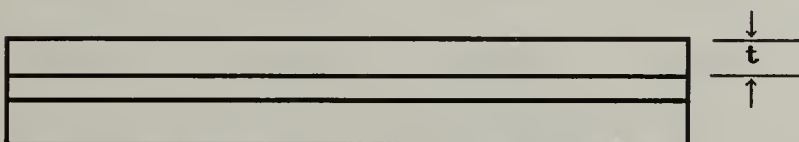
The windows tested by the Waterways Experiment Station were laminated windows composed of two 3/8" thick window plates. There are currently three ways, as illustrated in Figure 5-9, which have been suggested to determine an equivalent monolithic thickness for laminated glass. Method one is to assume the glass to be one monolithic plate with thickness equal to the entire overall thickness (glass and innerlayer). Method two is to



Method 1 - Total Thickness (t)



Method 2 - Glass Thickness ($t + t$)



Method 3 - Single Plate Thickness (t)

Figure 5-9. Laminated Glass Thicknesses

assume the glass plate is a monolithic plate with thickness equal to the sum of the glass thicknesses only. Method three is to assume that the glass plate consists of two independent, stacked plates which share the load equally. Methods one and three provide performance bounds for the laminated plate. There is evidence to believe that method two provides realistic displacement performance but its relevance to overall strength is still uncertain. (10)

All three methods were used as input into WINBLAST to examine their performance. Table 5-4 presents a peak deflection comparison between the experimental data from the Waterways Experiment Station and WINBLAST, using all three methods of thickness determination.

Table 5-4. WINBLAST - vs - Experimental Data

| Window Size (in) | Load (psi) | Test Data ^a Deflection (in) | WINBLAST Deflections ^b | | |
|----------------------------|-------------------|--|------------------------------------|------------------------------------|--------------------------------------|
| | | | Method One ^c (in) | Method Two ^d (in) | Method Three ^e (in) |
| 26 x 26 | 14.6 | 0.15 | 0.0981 | 0.1414 | 0.4890 |
| 36 x 36 | 14.6 | 0.555 | 0.3475 | 0.5013 | 1.1296 |
| 40 x 40 | 14.6 | 0.685 | 0.5182 | 0.7205 | 1.4138 |

- a. Deflections shown are the measured deflections averaged over two separate tests. One or two deflection gages were used during each test.
- b. All WINBLAST deflection values in this table include 4% damping.
- c. Overall thickness (Glass and Innerlayer).
- d. Glass thickness only.
- e. Single plates sharing load equally.

Table 5-4 shows two things, first, that method two, using the thickness of the glass plates only, provides the most reasonable deflections, and second, it shows that the output generated by WINBLAST compares favorably to the test data. While it does not correspond as well as with the theoretical model (Table 5-2) it is still relatively close to the test data.

It should be noted that this author had no control or input into the Waterways Experiment Station tests and was not present during the tests. Therefore, no statement can be made regarding the accuracy of these data. It is not the intent of this paper to verify the Waterways Experiment Station testing procedures, but data on blasts on windows are limited, and some data are much better than no data at all. And since this author has no reason to doubt the accuracy of the Waterways Experiment Station data it has been used in this report as "reasonable test result data."

Numerous conditions could account for the up to 10% differences shown in Table 5-4, such as the actual blast pressure on the windows differing from the calculated value of 14.6 psi. Also the calculated duration of the blast of 26 milliseconds could easily vary based on the angle to the blast and the actual blast value. A myriad of other parameters could also have affected the data. As an example of this, the deflection gage readings for the 26" x 26" plate varied from 0.06 inches to 0.19 inches (over a 300% difference!). (3)

Conclusions

As shown above, WINBLAST provides a feasible approach to calculate the response of rectangular monolithic glass plates to uniform pressure loads. It is extremely quick, reasonably accurate, and does not require a large super-computer to run. The only draw back to this routine is that it can only be applied to rectangular plates. Non-rectangular plates cannot be input into WINBLAST. While this method only encompasses monolithic glass, as is shown, reasonable assumptions can be employed to allow the performance of laminated glass to be modeled as monolithic.

As the computer code expands in its applications and certain industrial uses are considered, additional user friendly routines should be included in the code. Modifications which should be considered include the ability to run multiple iterations before the program stops, a subroutine to calculate the design thickness of the window plates so that the input would be the measured thickness of the glass, and finally, some user-friendly routines to ask for input verification and some validity checks to allow re-entry of data rather than requiring an entirely new run.

The main thrust of future research should however, be toward using the output generated by WINBLAST to calculate equivalent loadings and durations which can be used for glass design.

In the meantime, it is recommended that WINBLAST be used as a reasonable method to determine deflections and stresses of an input rectangular window size for any uniform blast loading.

APPENDIX A: This appendix presents the computer code
WINBLAST. The Code is written in BASIC.


```

EM *****
EM *
EM *
EM *          WINBLAST
EM *          A COMPUTE CODE TO DETERMINE THE DISPLACEMENTS, VELOCITIES
EM *          ACCELERATIONS AND STRESSES IN HEAT TREATED GLASS PLATES
EM *          SUBJECTED TO UNIFORM LOADS USING AN EQUIVALENT SINGLE DEGREE
EM *          OF FREEDOM LINEAR DYNAMIC ANALYSIS.
EM *          PROGRAMMED DY DANIEL T. MAGRO LT, CEC, USN - AUGUST 1993
EM *
EM *****

EM *****
EM *
EM * DESCRIPTION OF VARIABLES:
EM *
EM * EMASS      - EQUIVALENT MASS FACTORS
EM * EDISP      - MAXIMUM PLATE DISPLACEMENTS CORRESPONDING TO THE
EM *              EQUIVALENT FACTORS IN "EDISP" AND "EFORCE"
EM * EFORCE     - EQUIVALENT FORCE FACTORS
EM * ESPRING    - SPRING CONSTANTS CALCULATED FOR EACH CORRESPONDING
EM *              DISPLACEMENT IN "EDISP"
EM * STRESS     - MAXIMUM PLATE STRESS CORRESPONDING TO "EDISP"
EM * LOAD       - LOADS APPLIED TO DEVELOPE THE DISPLACEMENTS IN
EM *              "EDISP"
EM * EQDISP     - MAXIMUM DISPLACEMENTS CORRECTED TO THE ACTUAL
EM *              ASPECT RATIO
EM * EQMASS     - EQUIVALENT MASS FACTORS CORRECTED TO THE ACTUAL
EM *              ASPECT RATIO
EM * EQFORCE    - EQUIVALENT FORCE FACTORS CORRECTED TO THE ACTUAL
EM *              ASPECT RATIO
EM * EQSPRING   - SPRING CONSTANT CORRECTED TO THE ACTUAL ASPECT
EM *              RATIO
EM * EQSTRESS   - MAXIMUM PLATE STRESS CORRECTED TO THE ACTUAL ASPECT
EM *              RATIO
EM * QMASS      - SYSTEM MASS USED IN DYNAMIC ANALYSIS
EM * QFORCE     - SYSTEM FORCE USED IN DYNAMIC ANALYSIS
EM * QSPRING    - SYSTEM SPRING CONSTANT USED IN DYNAMIC ANALYSIS
EM * QSTRESS    - PLATE STRESS RESULTING FROM DYNAMIC ANALYSIS
EM * F          - FORCE OF LOAD ON PLATE IN PSI
EM * PFORCE     - PEAK FORCE ON ENTIRE PLATE RESULTING FROM "F"
EM * FORCE       - THE CALCULATED FORCE APPLIED TO THE GLASS PLATE AS
EM *              A FUNCTION OF TIME
EM * DURATION   - TOTAL DURATION OF THE BLAST LOADING
EM * DESIRE     - THE TOTAL DYNAMIC ANALYSIS TIME
EM * TIME       - THE TIME AT WHICH THE MAXIMUM DEFLECTION IS REACHED
EM * T          - THE CURRENT TIME IN THE DYNAMIC ANALYSIS
EM * LENGTH     - PLATE LENGTH
EM * LWIDTH     - THE PLATE WIDTH
EM * THICK      - THE PLATE THICKNESS
EM * RATIO      - THE ASPECT RATIO OF THE PLATE
EM * J1         - ARRAY VARIABLE USED TO DESIGNATE THE ASPECT RATIO
EM *              IMMEDIATELY TO THE LEFT OF THE PLATE ASPECT RATIO
EM * J2         - ARRAY VARIABLE USED TO DESIGNATE THE ASPECT RATIO
EM *              IMMEDIATELY TO THE RIGHT OF THE PLATE ASPECT RATIO
EM * LEFT       - EQUIVALENT TO "J1" (SEE "J1" ABOVE)
EM * FACTORJ1   - USED IN LINEAR INTERPOLATION BETWEEN ASPECT RATIOS
EM * FACTORJ2   - USED IN LINEAR INTERPOLATION BETWEEN ASPECT RATIOS

```



```

EM * DAMP          - PERCENTAGE OF DAMPING IN THE SYSTEM          *
EM * DAMPING       - CRITICAL DAMPING OF THE SYSTEM              *
EM * D             - DUMMY VARIABLE USED TO OUTPUT DAMPING VALUE  *
EM * DAMP1         - VALUE CALCULATED IN THE LINEAR ACCELERATION METHOD *
EM *              - WHICH IS MULTIPLIED BY THE CRITICAL DAMPING VALUE *
EM * MAX           - MAXIMUM DEFLECTION OF THE PLATE              *
EM * AREA          - AREA OF THE PLATE                           *
EM * MASS          - MASS OF THE PLATE                           *
EM * MASS1         - VALUE CALCULATED IN THE LINEAR ACCELERATION METHOD *
EM *              - WHICH IS MULTIPLIED BY THE TOTAL MASS OF THE SYSTEM *
EM * DELTAT        - TIME STEP USED DURING THE DYNAMIC ANALYSIS  *
EM * TEST          - ABSOLUTE VALUE OF THE TOTAL DISPLACEMENT USED TO *
EM *              - DETERMINE CORRECT EQUIVALENT VALUES          *
EM * DISTANCE      - DISPLACEMENT DISTANCE BETWEEN EQUIVALENT FACTORS *
EM * DIST          - DISTANCE PLATE IS DEFLECTED INTO THE NEXT HIGHEST *
EM *              - EQUIVALENT FACTORS                            *
EM * COUNT         - DUMMY VARIABLE USED TO CONTROL THE TOTAL OUTPUT *
EM * SLOPES        - LINEAR SLOPE BETWEEN SPRING CONSTANT FACORS   *
EM * SLOPEF        - LINEAR SLOPE BETWEEN EQUIVALENT FORCE FACORS   *
EM * SLOPEM        - LINEAR SLOPE BETWEEN EQUIVALENT MASS FACORS   *
EM * SLOPER        - LINEAR SLOPE BETWEEN MAXIMUM STRESS VALUES   *
EM * R1            - VARIABLE USED DURING THE DYNAMIC ANALYSIS    *
EM * K1            - VARIABLE USED DURING THE DYNAMIC ANALYSIS    *
EM * TDISP         - TOTAL DISPLACEMENT OF THE WINDOW PLATE       *
EM * DDISP         - CHANGE IN DISPLACEMENT FROM ONE TIME STEP    *
EM * DISP1         - DISPLACEMENT CREATED DURING ANY GIVEN TIME STEP *
EM * TVEL          - TOTAL VELOCITY OF THE PLATE                  *
EM * DVEL          - CHANGE IN THE VELOCITY FROM ONE TIME STEP     *
EM * TACCEL        - TOTAL ACCELERATION OF THE PLATE              *
EM * DACCEL        - CHANGE IN ACCELERATION FROM ONE TIME STEP     *
EM * A0            - LINEAR ACCELERATION CONSTANT A0              *
EM * A1            - LINEAR ACCELERATION CONSTANT A1              *
EM * A2            - LINEAR ACCELERATION CONSTANT A2              *
EM * A3            - LINEAR ACCELERATION CONSTANT A3              *
EM * A4            - LINEAR ACCELERATION CONSTANT A4              *
EM * A5            - LINEAR ACCELERATION CONSTANT A5              *
EM * I, J, K, L    - COUNTER VARIABLES USED IN FOR-NEXT LOOPS     *
EM * M, R, S       - COUNTER VARIABLES USED IN FOR-NEXT LOOPS     *
EM * GRADIN        - FILE USED TO HOLD EQUIVALENT FACTORS FOR ALL RATIOS *
EM * STR30         - FILE USED TO STORE ALL MAXIMUM STRESS VALUES *
EM *              *
EM *****

```

```

EM DIMENSION THE VARIABLES

```

```

EM EMASS#(31, 21), EDISP#(31, 21), EFORCE#(31, 21), ESPRING#(31, 21)
EM LOAD#(31), STRESS#(31, 21), EQSTRESS#(31)
EM EQMASS#(31), EQDISP#(31), EQFORCE#(31), EQSPRING#(31)

```

```

EM INPUT ALL VARIABLES

```

```

INPUT "BLAST PRESSURE (psi)      : ", F#
INPUT "BLAST DURATION (msec)    : ", DURATION#
INPUT "WINDOW LENGTH (in)      : ", LENGTH#

```



```

INPUT "WINDOW WIDTH      (in)      : ", LWIDTH#
INPUT "GLASS THICKNESS (in)      : ", THICK#
INPUT "SYSTEM DAMPING (4%=.04) : ", DAMP#
PRINT "INPUT TOTAL ANALYSIS TIME DESIRED (IN MILLISECONDS)"
INPUT "USUALLY 6-15 ms WILL BE ADEQUATE TO REACH PEAK : ", DESIRE

```

```

REM SET UP ALL LOAD, MASS, DISP., AND FORCE DATA

```

```

DO R = 1 TO 31
  READ LOAD#(R)
NEXT R
OPEN "I", #1, "A:GRADIN.PRN"
DO L = 1 TO 21
  FOR K = 1 TO 31
    INPUT #1, EMASS#(K, L), EDISP#(K, L), EFORCE#(K, L)
  NEXT K
NEXT L
CLOSE #1
OPEN "I", #2, "A:STR30.DAT"
DO L = 1 TO 21
  FOR K = 1 TO 31
    INPUT #2, STRESS#(K, L)
  NEXT K
NEXT L
CLOSE #2

```

```

RATIO# = LENGTH# / LWIDTH#
IF RATIO# < 1! THEN RATIO# = LWIDTH# / LENGTH#
DAMP# = 100# * DAMP#
DAMP# = 0
DISP# = 0
VEL# = 0
AX# = 0

```

```

REM LPRINT THE INITIAL CONDITIONS

```

```

PRINT "                INPUT DATA FOR WINBLAST PROGRAM:"
PRINT "                *****"
PRINT "                BLAST PRESSURE = "; F#; " psi "
PRINT "                BLAST DURATION = "; DURATION#; " msec"
PRINT "                GLASS THICKNESS = "; THICK#; " in."
PRINT "                WINDOW SIZE = "; LENGTH#; " x "; LWIDTH#
PRINT "                ASPECT RATIO = "; RATIO#
PRINT "                DAMPING PERCENTAGE = "; D#; " %"

```

```

PRINT "                TIME          DISPLACEMENT    VELOCITY          ACCELERATION          STR
PRINT "                (sec)          (in)           (in/sec)           (in/sec2)           (p
PRINT "                -----          -----          -----          -----          ---

```

```

REM CALCULATE CONSTANTS

```

```

DELTAT# = .00001#
G# = 6# / (DELTAT# ^ 2#)
A# = 3# / DELTAT#
F# = 6# / DELTAT#
M# = 2#
D# = 2#
D# = DELTAT# / 2#

```


EM CALCULATE WHICH ASPECT RATIO VECTORS WILL BE USED (THE 'J' COMPONENT)

```
F RATIO# >= 1! AND RATIO# <= 1.2 THEN
J1 = 1
J2 = 2
LEFT# = 1!
ELSEIF RATIO# > 1.2 AND RATIO# <= 1.4 THEN
J1 = 2
J2 = 3
LEFT# = 1.2
ELSEIF RATIO# > 1.4 AND RATIO# <= 1.6 THEN
J1 = 3
J2 = 4
LEFT# = 1.4
ELSEIF RATIO# > 1.6 AND RATIO# <= 1.8 THEN
J1 = 4
J2 = 5
LEFT# = 1.6
ELSEIF RATIO# > 1.8 AND RATIO# <= 2! THEN
J1 = 5
J2 = 6
LEFT# = 1.8
ELSEIF RATIO# > 2! AND RATIO# <= 2.2 THEN
J1 = 6
J2 = 7
LEFT# = 2!
ELSEIF RATIO# > 2.2 AND RATIO# <= 2.4 THEN
J1 = 7
J2 = 8
LEFT# = 2.2
ELSEIF RATIO# > 2.4 AND RATIO# <= 2.6 THEN
J1 = 8
J2 = 9
LEFT# = 2.4
ELSEIF RATIO# > 2.6 AND RATIO# <= 2.8 THEN
J1 = 9
J2 = 10
LEFT# = 2.6
ELSEIF RATIO# > 2.8 AND RATIO# <= 3! THEN
J1 = 10
J2 = 11
LEFT# = 2.8
ELSEIF RATIO# > 3! AND RATIO# <= 3.2 THEN
J1 = 11
J2 = 12
LEFT# = 3!
ELSEIF RATIO# > 3.2 AND RATIO# <= 3.4 THEN
J1 = 12
J2 = 13
LEFT# = 3.2
ELSEIF RATIO# > 3.4 AND RATIO# <= 3.6 THEN
J1 = 13
J2 = 14
LEFT# = 3.4
```



```

ELSEIF RATIO# > 3.6 AND RATIO# <= 3.8 THEN
    J1 = 14
    J2 = 15
    LEFT# = 3.6
ELSEIF RATIO# > 3.8 AND RATIO# <= 4! THEN
    J1 = 15
    J2 = 16
    LEFT# = 3.8
ELSEIF RATIO# > 4! AND RATIO# <= 4.2 THEN
    J1 = 16
    J2 = 17
    LEFT# = 4!
ELSEIF RATIO# > 4.2 AND RATIO# <= 4.4 THEN
    J1 = 17
    J2 = 18
    LEFT# = 4.2
ELSEIF RATIO# > 4.4 AND RATIO# <= 4.6 THEN
    J1 = 18
    J2 = 19
    LEFT# = 4.4
ELSEIF RATIO# > 4.6 AND RATIO# <= 4.8 THEN
    J1 = 19
    J2 = 20
    LEFT# = 4.6
ELSEIF RATIO# > 4.8 AND RATIO# <= 5! THEN
    J1 = 20
    J2 = 21
    LEFT# = 4.8
ELSEIF RATIO# > 5! THEN
    LPRINT "WINDOW SIZE EXCEEDS PROGRAMS CAPABILITY"
ND IF

REA# = LENGTH# * LWIDTH#
FORCE# = F# * AREA#
ASS# = AREA# * THICK# * 161# / (386.4# * 1728#)

EM DIMENSIONALIZE THE DISPLACEMENTS, STRESSES AND, LOADS

OR I = 1 TO 31
    EDISP#(I, J1) = EDISP#(I, J1) * THICK#
    EDISP#(I, J2) = EDISP#(I, J2) * THICK#
    STRESS#(I, J1) = STRESS#(I, J1) * 10400000 * THICK# ^ 2 / AREA#
    STRESS#(I, J2) = STRESS#(I, J2) * 10400000 * THICK# ^ 2 / AREA#
EXT I

OR S = 1 TO 31
    LOAD#(S) = LOAD#(S) * 10400000# * THICK# ^ 4 / AREA#
EXT S

EM CALCULATE THE SPRING CONSTANTS FOR THE TWO ASPECT RATIOS

OR I = 1 TO 31
    SPRING#(I, J1) = LOAD#(I) / EDISP#(I, J1)
    SPRING#(I, J2) = LOAD#(I) / EDISP#(I, J2)
EXT I

```


EM CALCULATE THE ACTUAL VALUES FOR EQUIVALENT MASS, EQUIVALENT FORCE,
EM EQUIVALENT SPRING, AND EQUIVALENT DISPLACEMENTS

FACTORJ2# = (RATIO# - LEFT#) / .2#
FACTORJ1# = 1# - FACTORJ2#

FOR E = 1 TO 31

EQMASS#(E) = (EMASS#(E, J1) * FACTORJ1# + EMASS#(E, J2) * FACTORJ2#)
EQDISP#(E) = (EDISP#(E, J1) * FACTORJ1# + EDISP#(E, J2) * FACTORJ2#)
EQFORCE#(E) = (EFORCE#(E, J1) * FACTORJ1# + EFORCE#(E, J2) * FACTORJ2#)
ESPRING#(E) = (ESPRING#(E, J1) * FACTORJ1# + ESPRING#(E, J2) * FACTORJ2#)
EQSTRESS#(E) = (STRESS#(E, J1) * FACTORJ1# + STRESS#(E, J2) * FACTORJ2#)
NEXT E

ACCEL# = PFORCE# * EQFORCE#(1) / (10# * MASS# * EQMASS#(1))

FOR I = 1 TO 31

UNT# = -1#

SIRE = DESIRE * 100
FOR I = 1 TO DESIRE

SUB 3000

FOR I = 1 TO 31
M DETERMINE EQUIVALENT LOADINGS FROM GLASS DEFLECTION PRIOR TO LINEAR
M ACCELERATION METHOD

TEST# = ABS(TDISP#)

IF (TEST# <= EQDISP#(1)) THEN

L = 1

ELSEIF TEST# > EQDISP#(1) AND TEST# <= EQDISP#(2) THEN L = 2
ELSEIF TEST# > EQDISP#(2) AND TEST# <= EQDISP#(3) THEN L = 3
ELSEIF TEST# > EQDISP#(3) AND TEST# <= EQDISP#(4) THEN L = 4
ELSEIF TEST# > EQDISP#(4) AND TEST# <= EQDISP#(5) THEN L = 5
ELSEIF TEST# > EQDISP#(5) AND TEST# <= EQDISP#(6) THEN L = 6
ELSEIF TEST# > EQDISP#(6) AND TEST# <= EQDISP#(7) THEN L = 7
ELSEIF TEST# > EQDISP#(7) AND TEST# <= EQDISP#(8) THEN L = 8
ELSEIF TEST# > EQDISP#(8) AND TEST# <= EQDISP#(9) THEN L = 9
ELSEIF TEST# > EQDISP#(9) AND TEST# <= EQDISP#(10) THEN L = 10
ELSEIF TEST# > EQDISP#(10) AND TEST# <= EQDISP#(11) THEN L = 11
ELSEIF TEST# > EQDISP#(11) AND TEST# <= EQDISP#(12) THEN L = 12
ELSEIF TEST# > EQDISP#(12) AND TEST# <= EQDISP#(13) THEN L = 13
ELSEIF TEST# > EQDISP#(13) AND TEST# <= EQDISP#(14) THEN L = 14
ELSEIF TEST# > EQDISP#(14) AND TEST# <= EQDISP#(15) THEN L = 15
ELSEIF TEST# > EQDISP#(15) AND TEST# <= EQDISP#(16) THEN L = 16
ELSEIF TEST# > EQDISP#(16) AND TEST# <= EQDISP#(17) THEN L = 17
ELSEIF TEST# > EQDISP#(17) AND TEST# <= EQDISP#(18) THEN L = 18
ELSEIF TEST# > EQDISP#(18) AND TEST# <= EQDISP#(19) THEN L = 19
ELSEIF TEST# > EQDISP#(19) AND TEST# <= EQDISP#(20) THEN L = 20
ELSEIF TEST# > EQDISP#(20) AND TEST# <= EQDISP#(21) THEN L = 21
ELSEIF TEST# > EQDISP#(21) AND TEST# <= EQDISP#(22) THEN L = 22
ELSEIF TEST# > EQDISP#(22) AND TEST# <= EQDISP#(23) THEN L = 23
ELSEIF TEST# > EQDISP#(23) AND TEST# <= EQDISP#(24) THEN L = 24
ELSEIF TEST# > EQDISP#(24) AND TEST# <= EQDISP#(25) THEN L = 25
ELSEIF TEST# > EQDISP#(25) AND TEST# <= EQDISP#(26) THEN L = 26
ELSEIF TEST# > EQDISP#(26) AND TEST# <= EQDISP#(27) THEN L = 27


```

ELSEIF TEST# > EQDISP#(27) AND TEST# <= EQDISP#(28) THEN L = 28
ELSEIF TEST# > EQDISP#(28) AND TEST# <= EQDISP#(29) THEN L = 29
ELSEIF TEST# > EQDISP#(29) AND TEST# <= EQDISP#(30) THEN L = 30
ELSE L = 31
END IF

```

```

QFORCE# = EQFORCE#(L) * FORCE#
QMASS# = EQMASS#(L) * MASS#
QSPRING# = EQSPRING#(L) * EQFORCE#(L)
QSTRESS# = EQSTRESS#(L)

```

```

IF L >= 2 THEN
M = L - 1
DISTANCE# = EQDISP#(L) - EQDISP#(M)
DIST# = ABS(TDISP#) - EQDISP#(M)

```

```

SLOPES# = (EQSPRING#(L) - EQSPRING#(M)) / DISTANCE#
SLOPEM# = (EQMASS#(L) - EQMASS#(M)) / DISTANCE#
SLOPEF# = (EQFORCE#(L) - EQFORCE#(M)) / DISTANCE#
SLOPER# = (EQSTRESS#(L) - EQSTRESS#(M)) / DISTANCE#

```

```

QSPRING# = (EQSPRING#(M) + (SLOPES# * DIST#)) * EQFORCE#(L)
QMASS# = (EQMASS#(M) + (SLOPEM# * DIST#)) * MASS#
QFORCE# = (EQFORCE#(M) + (SLOPEF# * DIST#)) * FORCE#
QSTRESS# = (EQSTRESS#(M) + (SLOPER# * DIST#))

```

```

END IF

```

```

DAMPING# = DAMP# * 2# * SQR(QSPRING# * QMASS#)
MASS1# = (A0# * TDISP#) + (A2# * TVEL#) + (A3# * TACCEL#)
DAMP1# = (A1# * TDISP#) + (A4# * TVEL#) + (A5# * TACCEL#)

```

```

R1# = QFORCE# + (QMASS# * MASS1#) + (DAMPING# * DAMP1#)
K1# = (A0# * QMASS#) + (A1# * DAMPING#) + QSPRING#
DISP1# = R1# / K1#
DDISP# = DISP1# - TDISP#
DVEL# = A1# * DDISP# - 3# * TVEL# - A5# * TACCEL#
DACCEL# = A0# * DDISP# - A2# * TVEL# - 3# * TACCEL#
TVEL# = TVEL# + DVEL#
TACCEL# = TACCEL# + DACCEL#
TDISP# = TDISP# + DDISP#

```

```

IF (ABS(TDISP#) > MAX#) THEN
MAX# = ABS(TDISP#)
TIME# = T#
END IF

```

```

COUNT# = COUNT# + 1
IF COUNT# = 10# THEN
LPRINT USING "          #.####          ##.####          #####.###          #####.##
COUNT# = 0

```

```

END IF
T# = T# + DELTAT#

```

```

XT I

```



```

PRINT " "
PRINT "          MAXIMUM DEFLECTION          TIME"
PRINT "          -----"          -----"
PRINT USING "          ##.####          #.#### "; MAX#; TIME#
ND

```

EM FORCE CALCULATION SUBROUTINE

```

ORCE# = T# * PFORCE# * 1000#
F T# * 1000# >= 1# THEN
  FORCE# = PFORCE# * (1# - ((T# * 1000#) - 1) / (DURATION# - 1))
  IF FORCE# < 0 THEN
    FORCE# = 0
  END IF
ND IF
RETURN
ND

```

EM LOAD DATA

```

ATA 9.97, 12.81, 16.44, 21.12, 27.11, 34.81, 44.7, 57.4
ATA 73.7, 94.63, 121.51, 156.02, 200.34, 257.24, 330.3, 424.11
ATA 544.57, 699.24, 897.85, 1152.86, 1480.3, 1900.74, 2440.6, 3133.8
ATA 4023.87, 5166.75, 6634.24, 8518.54, 10938.02, 14044.69, 18033.74

```


APPENDIX B: This appendix presents a sample input file for use in the ABAQUS analysis. This sample corresponds to a 40" x 40", 0.71" thick window plate subjected to a peak blast load of 14.6 psi over a 26 millisecond duration.

The boundary conditions and glass properties specified are generic for all cases analyzed. In order to analyze any other plate or loading conditions either the geometry of the plate or the "*AMPLITUDE" input must be altered.

ABAQUS Finite Element Input Code

```
*HEADING
BLAST DEFLECTIONS OF 40" X 40" WINDOW PLATE
**
**NODE DEFINITIONS
**
*NODE
1, 0.0, 0.0, 0.0
.
.
.
341, 40.0, 40.0, 0.0
**
**ELEMENT DEFINITIONS
**
*ELEMENT, TYPE=S8R5, ELSET=WINDOW
1, 1, 3, 35, 33, 2, 23, 34, 22
2, 3, 5, 37, 35, 4, 24, 36, 23
.
.
.
99, 305, 307, 339, 337, 306, 319, 338, 318
100, 307, 309, 341, 339, 308, 320, 340, 319
**
** CREATE NODE AND ELEMENT SETS OF THE CORNER ELEMENT FOR
** OUTPUT PURPOSES
**
*NSET, NSET=MIDDLE
262
*ELSET, ELSET=CORNER
73
**
** CREATE NODE SETS FOR THE EDGES OF THE PLATE FOR IMPLEMENTATION
** OF THE BOUNDARY CONDITIONS: BOTTOM = BOTTOM EDGE
** RTEDGE = RIGHT EDGE, LTEDGE = LEFT EDGE, & TOP = TOP
**
*NSET, NSET=BOTTOM, GENERATE
1, 18
*NSET, NSET=TOP, GENERATE
263, 279
*NSET, NSET=RTEDGE
29, 48, 58, 77, 87, 106, 116, 135, 145
164, 174, 193, 203, 222, 232, 251, 261, 280
```



```

*NSET, NSET=LTEDGE
20, 30, 49, 59, 78, 88, 107, 117, 136, 146
165, 175, 194, 204, 223, 233, 252
*SHELL SECTION, ELSET=WINDOW, MATERIAL=GLASS
.71
*MATERIAL, NAME=GLASS
*ELASTIC
10.4E6
**
** ENTER THE MATERIAL DENSITY - REQUIRED FOR DYNAMIC ANALYSIS
** GLASS= 161 LBS/CUBIC FOOT = 0.0002414 LBS/CUBIC INCH
**
*DENSITY
0.0002414
**
** IMPLEMENTATION OF BOUNDARY CONDITIONS. - ONLY ONE QUARTER OF
** THE WINDOW PLATE IS MODELED/ANALYZED SO THESE BOUNDARY
** CONDITIONS CONSIDER SYMMETRY.
**
*BOUNDARY
BOTTOM, 3
RTEDGE, 3
LTEDGE, 3
TOP, 3
1, 1, 3
21, 2, 3
**
** DESCRIBE THE BLAST LOAD: BASICALLY A TRIANGULAR LOADING FROM
** A PEAK PRESSURE OF 14.6 PSI TO ZERO AT 26 MILLISECONDS.
** ONE MILLISECOND IS USED TO DEVELOP THE BLAST PEAK
**
*AMPLITUDE, NAME=BLAST
0.0, 0.0, 0.001, 14.6, 0.026, 0.0, 1.0, 0.0
**
** BEGIN THE DYNAMIC ANALYSIS - THE FIRST, AND LARGEST, PEAK
** OCCURS WITHIN THE FIRST 5 OR 6 MILLISECONDS (DISCOVERED
** THRU TRIAL AND ERROR). SO, IN ORDER TO KEEP COMPUTER TIME
** TO A MINIMUM, THE PROGRAM ONLY LOOKS AT THE FIRST 6
** MILLISECONDS.
**
*STEP, NLGEOM, INC=60, CYCLE=20
*DYNAMIC, PTOL=1.0
0.0001, 1.0
*DLOAD, AMPLITUDE=BLAST
WINDOW, P, 1.0
**

```



```
** OUTPUT IS SPECIFIC TO THE CORNER QUANTITIES AND ONLY PRINTED
**      OUT EVERY 10 INCREMENTS - WHICH CORRESPONDS TO EVERY
**      MILLISECOND.
**
*EL FILE, ELSET=CORNER, FREQUENCY=10, POSITION=AVERAGED AT NODES
S
*EL PRINT, ELSET=CORNER, FREQUENCY=10, POSITION=AVERAGED AT NODES
S
*NODE FILE, NSET=MIDDLE, FREQUENCY=10
U
*NODE PRINT, NSET=MIDDLE, FREQUENCY=10
U
*END STEP
```


APPENDIX C: This appendix presents the output generated by WINBLAST. These tabular data show displacements, velocities, accelerations, and stresses as time progresses. At the end of each data set the maximum deflection and corresponding time is displayed.

The output included in this appendix is as shown on the following page.

| <u>WINDOW SIZE</u> | <u>THICKNESS</u> | <u>LOAD</u> | <u>DAMPING</u> | <u>PAGE NO.</u> |
|--------------------|------------------|-------------|----------------|-----------------|
| 26 x 26 | 0.71 | 14.6 | 0% | C-3 |
| 36 x 36 | 0.71 | 14.6 | 0% | C-4 |
| 40 x 40 | 0.71 | 14.6 | 0% | C-6 |
| 72 x 72 | 1.06 | 14.6 | 0% | C-8 |
| 72 x 72 | 1.06 | 30.0 | 0% | C-19 |
| 72 x 72 | 1.06 | 40.0 | 0% | C-21 |
| 72 x 72 | 1.06 | 50.0 | 0% | C-23 |
| 27 x 20 | 0.71 | 14.6 | 0% | C-25 |
| 32 x 20 | 0.71 | 14.6 | 0% | C-26 |
| 72 x 24 | 0.71 | 14.6 | 0% | C-27 |
| 72 x 24 | 0.71 | 75.0 | 0% | C-29 |
| 26 x 26 | 0.71 | 14.6 | 4% | C-31 |
| 26 x 26 | 0.355 | 7.3 | 4% | C-32 |
| 26 x 26 | 0.801 | 14.6 | 4% | C-34 |
| 36 x 36 | 0.71 | 14.6 | 4% | C-36 |
| 36 x 36 | 0.355 | 7.3 | 4% | C-38 |
| 36 x 36 | 0.809 | 14.6 | 4% | C-40 |
| 40 x 40 | 0.71 | 14.6 | 4% | C-42 |
| 40 x 40 | 0.355 | 7.3 | 4% | C-44 |
| 40 x 40 | 0.808 | 14.6 | 4% | C-46 |

INPUT DATA FOR WINBLAST PROGRAM:

BLAST PRESSURE = 14.6 psi
 BLAST DURATION = 26 msec
 GLASS THICKNESS = .71 in.
 WINDOW SIZE = 26 x 26
 ASPECT RATIO = 1
 DAMPING PERCENTAGE = 0 %

| TIME (sec) | DISPLACEMENT (in) | VELOCITY (in/sec) | ACCELERATION (in/sec ²) | STRESS (psi) |
|---------------|----------------------|----------------------|--|-----------------|
| 0001 | 0.0000 | 0.745 | 13524.6847 | 1.5471 |
| 0002 | 0.0002 | 2.765 | 26821.1238 | 11.2821 |
| 0003 | 0.0006 | 6.094 | 39663.4022 | 38.1314 |
| 0004 | 0.0015 | 10.675 | 51834.0620 | 90.7485 |
| 0005 | 0.0028 | 16.431 | 63127.0181 | 177.3507 |
| 0006 | 0.0048 | 23.265 | 73351.0474 | 305.5795 |
| 0007 | 0.0075 | 31.060 | 82333.0268 | 482.3718 |
| 0008 | 0.0110 | 39.685 | 89920.8650 | 713.8421 |
| 0009 | 0.0154 | 48.993 | 95986.0775 | 1005.1790 |
| 0010 | 0.0208 | 58.827 | 100425.9622 | 1360.5574 |
| 0011 | 0.0272 | 68.316 | 89086.9398 | 1781.9162 |
| 0012 | 0.0345 | 76.594 | 76239.4124 | 2263.8534 |
| 0013 | 0.0425 | 83.521 | 62100.9266 | 2797.8459 |
| 0014 | 0.0511 | 88.979 | 46910.8888 | 3374.4871 |
| 0015 | 0.0602 | 92.877 | 30926.5111 | 3983.6485 |
| 0016 | 0.0696 | 95.147 | 14418.4563 | 4614.6509 |
| 0017 | 0.0792 | 95.752 | -2333.7456 | 5256.4452 |
| 0018 | 0.0887 | 94.682 | -19046.4302 | 5897.7996 |
| 0019 | 0.0981 | 91.954 | -35436.6026 | 6527.4898 |
| 0020 | 0.1071 | 87.614 | -51226.7286 | 7134.4890 |
| 0021 | 0.1155 | 81.737 | -66149.4349 | 7708.1545 |
| 0022 | 0.1234 | 74.422 | -79952.0359 | 8238.4081 |
| 0023 | 0.1304 | 65.792 | -92400.8129 | 8715.9068 |
| 0024 | 0.1365 | 55.994 | -103284.9712 | 9132.2008 |
| 0025 | 0.1415 | 45.194 | -112420.2101 | 9479.8766 |
| 0026 | 0.1455 | 33.574 | -119651.8428 | 9752.6828 |
| 0027 | 0.1482 | 21.331 | -124857.4165 | 9945.6357 |
| 0028 | 0.1497 | 8.673 | -127948.7855 | 10055.1036 |
| 0029 | 0.1500 | -4.186 | -128873.6038 | 10078.8685 |
| 0030 | 0.1489 | -17.028 | -127616.2114 | 10016.1639 |
| 0031 | 0.1466 | -29.636 | -124197.8997 | 9867.6871 |
| 0032 | 0.1430 | -41.797 | -118676.5509 | 9635.5879 |
| 0033 | 0.1382 | -53.304 | -111145.6577 | 9323.4321 |
| 0034 | 0.1324 | -63.963 | -101732.7402 | 8936.1412 |
| 0035 | 0.1255 | -73.593 | -90597.1871 | 8479.9088 |
| 0036 | 0.1177 | -82.031 | -77927.5561 | 7962.0959 |
| 0037 | 0.1091 | -89.135 | -63938.3815 | 7391.1064 |
| 0038 | 0.0999 | -94.783 | -48866.5413 | 6776.2443 |
| 0039 | 0.0902 | -98.880 | -32967.2463 | 6127.5569 |

| | |
|--------------------|--------|
| MAXIMUM DEFLECTION | TIME |
| ----- | ---- |
| 0.1500 | 0.0029 |

INPUT DATA FOR WINBLAST PROGRAM:

BLAST PRESSURE = 14.6 psi
 BLAST DURATION = 26 msec
 GLASS THICKNESS = .71 in.
 WINDOW SIZE = 36 x 36
 ASPECT RATIO = 1
 DAMPING PERCENTAGE = 0 %

| TIME (sec) | DISPLACEMENT (in) | VELOCITY (in/sec) | ACCELERATION (in/sec ²) | STRESS (psi) |
|---------------|----------------------|----------------------|--|-----------------|
| ----- | ----- | ----- | ----- | ----- |
| 0001 | 0.0000 | 0.746 | 13561.4822 | 0.8077 |
| 0002 | 0.0002 | 2.778 | 27060.6307 | 5.9006 |
| 0003 | 0.0006 | 6.154 | 40434.9819 | 20.0023 |
| 0004 | 0.0015 | 10.859 | 53622.8564 | 47.8035 |
| 0005 | 0.0028 | 16.870 | 66563.4347 | 93.9317 |
| 0006 | 0.0049 | 24.161 | 79197.0381 | 162.9301 |
| 0007 | 0.0077 | 32.698 | 91465.4031 | 259.2361 |
| 0008 | 0.0115 | 42.440 | 103311.9510 | 387.1614 |
| 0009 | 0.0162 | 53.344 | 114682.0483 | 550.8719 |
| 0010 | 0.0222 | 65.359 | 125523.2587 | 754.3682 |
| 0011 | 0.0293 | 77.724 | 121678.1728 | 1000.8667 |
| 0012 | 0.0377 | 89.676 | 117271.9355 | 1290.1351 |
| 0013 | 0.0472 | 101.160 | 112324.8674 | 1620.6500 |
| 0014 | 0.0579 | 112.123 | 106859.7832 | 1990.6970 |
| 0015 | 0.0697 | 122.515 | 100901.8865 | 2398.3791 |
| 0016 | 0.0824 | 132.288 | 94478.6539 | 2841.6261 |
| 0017 | 0.0961 | 141.396 | 87619.7077 | 3318.2036 |
| 0018 | 0.1107 | 149.799 | 80356.6799 | 3825.7234 |
| 0019 | 0.1260 | 157.455 | 72723.0658 | 4361.6549 |
| 0020 | 0.1421 | 164.332 | 64754.0698 | 4923.3360 |
| 0021 | 0.1589 | 170.396 | 56486.4432 | 5507.9864 |
| 0022 | 0.1762 | 175.620 | 47958.3142 | 6112.7194 |
| 0023 | 0.1940 | 179.980 | 39209.0127 | 6734.5559 |
| 0024 | 0.2121 | 183.456 | 30278.8884 | 7370.4381 |
| 0025 | 0.2306 | 186.032 | 21209.1248 | 8017.2430 |
| 0026 | 0.2493 | 187.695 | 12041.5498 | 8671.7976 |
| 0027 | 0.2681 | 188.438 | 2818.4419 | 9330.8929 |
| 0028 | 0.2870 | 188.258 | -6417.6640 | 9991.2992 |
| 0029 | 0.3057 | 187.155 | -15624.1731 | 10649.7805 |
| 0030 | 0.3244 | 185.115 | -25465.5772 | 11312.8045 |
| 0031 | 0.3427 | 182.083 | -35159.4654 | 11985.6554 |
| 0032 | 0.3608 | 178.087 | -44738.5417 | 12646.0040 |
| 0033 | 0.3783 | 173.141 | -54150.6947 | 13290.3435 |
| 0034 | 0.3954 | 167.264 | -63343.5526 | 13915.2263 |
| 0035 | 0.4117 | 160.409 | -73304.3477 | 14519.4160 |
| 0036 | 0.4274 | 152.636 | -82096.4461 | 15097.7329 |
| 0037 | 0.4422 | 144.002 | -90507.2031 | 15646.2086 |
| 0038 | 0.4562 | 134.549 | -98483.3955 | 16161.7392 |
| 0039 | 0.4691 | 124.322 | -105973.6534 | 16641.3780 |
| 0040 | 0.4810 | 113.372 | -112928.9691 | 17082.3555 |
| 0041 | 0.4918 | 101.755 | -119303.1972 | 17482.0964 |
| 0042 | 0.5013 | 89.442 | -126728.6624 | 17837.7210 |
| 0043 | 0.5096 | 76.502 | -131954.5388 | 18146.8361 |
| 0044 | 0.5166 | 63.076 | -136452.3879 | 18407.7718 |
| 0045 | 0.5222 | 49.237 | -140189.1576 | 18618.8529 |
| 0046 | 0.5265 | 35.064 | -143137.3352 | 18778.6816 |
| 0047 | 0.5293 | 20.637 | -145275.2915 | 18886.1484 |
| 0048 | 0.5306 | 6.037 | -146587.5541 | 18940.4399 |

| | | | | |
|-------|--------|----------|--------------|------------|
| .0049 | 0.5305 | -8.652 | -147065.0046 | 18941.0447 |
| .0050 | 0.5289 | -23.348 | -146704.9957 | 18887.7573 |
| .0051 | 0.5258 | -37.966 | -145511.3859 | 18780.6789 |
| .0052 | 0.5213 | -52.423 | -143494.4912 | 18620.2163 |
| .0053 | 0.5153 | -66.637 | -140670.9545 | 18407.0786 |
| .0054 | 0.5080 | -80.530 | -137063.5346 | 18142.2712 |
| .0055 | 0.4992 | -94.025 | -132700.8199 | 17827.0876 |
| .0056 | 0.4892 | -106.977 | -126122.1973 | 17462.7325 |
| .0057 | 0.4778 | -119.316 | -120548.9487 | 17051.2998 |
| .0058 | 0.4653 | -131.067 | -114356.6807 | 16595.3702 |
| .0059 | 0.4517 | -142.168 | -107588.5167 | 16097.1960 |
| .0060 | 0.4369 | -152.566 | -100290.8519 | 15559.2425 |
| .0061 | 0.4212 | -162.210 | -92512.8621 | 14984.1714 |
| .0062 | 0.4045 | -171.055 | -84305.9968 | 14374.8228 |
| .0063 | 0.3870 | -179.013 | -74945.3452 | 13735.8022 |
| .0064 | 0.3687 | -186.075 | -66245.3456 | 13070.5281 |
| .0065 | 0.3498 | -192.253 | -57274.2764 | 12380.7121 |
| .0066 | 0.3303 | -197.523 | -48083.9050 | 11669.6243 |
| .0067 | 0.3103 | -201.858 | -38369.7468 | 10946.4478 |
| .0068 | 0.2900 | -205.254 | -29518.1726 | 10234.0064 |
| .0069 | 0.2693 | -207.757 | -20530.4675 | 9510.9114 |
| .0070 | 0.2484 | -209.357 | -11448.0807 | 8780.3076 |
| .0071 | 0.2275 | -210.045 | -2312.8981 | 8045.3738 |
| .0072 | 0.2065 | -209.819 | 6832.9512 | 7309.3094 |
| .0073 | 0.1855 | -208.680 | 15947.2884 | 6575.3186 |
| .0074 | 0.1648 | -206.632 | 24988.0805 | 5846.5961 |

MAXIMUM DEFLECTION

TIME

0.5307

0.0048

INPUT DATA FOR WINBLAST PROGRAM:

BLAST PRESSURE = 14.6 psi
 BLAST DURATION = 26 msec
 GLASS THICKNESS = .71 in.
 WINDOW SIZE = 40 x 40
 ASPECT RATIO = 1
 DAMPING PERCENTAGE = 0 %

| TIME (sec) | DISPLACEMENT (in) | VELOCITY (in/sec) | ACCELERATION (in/sec2) | STRESS (psi) |
|---------------|----------------------|----------------------|---------------------------|-----------------|
| ----- | ----- | ----- | ----- | ----- |
| 0001 | 0.0000 | 0.746 | 13566.2176 | 0.6543 |
| 0002 | 0.0002 | 2.780 | 27091.5182 | 4.7812 |
| 0003 | 0.0006 | 6.162 | 40534.8350 | 16.2137 |
| 0004 | 0.0015 | 10.883 | 53855.4858 | 38.7699 |
| 0005 | 0.0029 | 16.928 | 67013.1600 | 76.2343 |
| 0006 | 0.0049 | 24.278 | 79968.0400 | 132.3462 |
| 0007 | 0.0077 | 32.913 | 92680.9220 | 210.7885 |
| 0008 | 0.0115 | 42.805 | 105113.3345 | 315.1764 |
| 0009 | 0.0164 | 53.925 | 117227.6546 | 449.0469 |
| 0010 | 0.0224 | 66.239 | 128987.2222 | 615.8474 |
| 0011 | 0.0296 | 79.004 | 126245.3065 | 818.4389 |
| 0012 | 0.0381 | 91.475 | 123121.3492 | 1056.9413 |
| 0013 | 0.0479 | 103.615 | 119624.8040 | 1330.4793 |
| 0014 | 0.0589 | 115.388 | 115766.2521 | 1638.0711 |
| 0015 | 0.0710 | 126.757 | 111557.3702 | 1978.6316 |
| 0016 | 0.0842 | 137.688 | 107010.8951 | 2350.9762 |
| 0017 | 0.0985 | 148.148 | 102140.5853 | 2753.8240 |
| 0018 | 0.1138 | 158.106 | 96961.1793 | 3185.8018 |
| 0019 | 0.1301 | 167.531 | 91488.3508 | 3645.4483 |
| 0020 | 0.1473 | 176.394 | 85738.6617 | 4131.2183 |
| 0021 | 0.1653 | 184.670 | 79729.5116 | 4641.4877 |
| 0022 | 0.1842 | 192.332 | 73479.0853 | 5174.5583 |
| 0023 | 0.2038 | 199.358 | 67006.2978 | 5728.6627 |
| 0024 | 0.2241 | 205.727 | 60330.7368 | 6301.9701 |
| 0025 | 0.2449 | 211.418 | 53472.6039 | 6892.5914 |
| 0026 | 0.2663 | 216.416 | 46452.6531 | 7498.5851 |
| 0027 | 0.2882 | 220.704 | 39292.1279 | 8117.9634 |
| 0028 | 0.3104 | 224.270 | 32012.6975 | 8748.6977 |
| 0029 | 0.3330 | 227.071 | 23966.2895 | 9406.7193 |
| 0030 | 0.3558 | 229.067 | 15919.1720 | 10081.9380 |
| 0031 | 0.3788 | 230.251 | 7756.8470 | 10762.1097 |
| 0032 | 0.4018 | 230.612 | -1093.8003 | 11445.0870 |
| 0033 | 0.4249 | 230.078 | -9599.3557 | 12131.1098 |
| 0034 | 0.4478 | 228.691 | -18148.6475 | 12814.5282 |
| 0035 | 0.4706 | 226.448 | -26710.1222 | 13492.7988 |
| 0036 | 0.4931 | 223.349 | -35251.0837 | 14163.3737 |
| 0037 | 0.5152 | 219.302 | -44987.7987 | 14822.3924 |
| 0038 | 0.5369 | 214.370 | -53647.7592 | 15468.0374 |
| 0039 | 0.5581 | 208.577 | -62186.6731 | 16098.0084 |
| 0040 | 0.5786 | 201.938 | -70565.4825 | 16709.7661 |
| 0041 | 0.5984 | 194.470 | -78744.7795 | 17300.8180 |
| 0042 | 0.6175 | 186.134 | -88527.4430 | 17866.7881 |
| 0043 | 0.6356 | 176.881 | -96482.4754 | 18402.8553 |
| 0044 | 0.6528 | 166.849 | -104107.0769 | 18910.8190 |
| 0045 | 0.6690 | 156.072 | -111358.9383 | 19388.4303 |
| 0046 | 0.6840 | 144.591 | -118197.0377 | 19833.5486 |
| 0047 | 0.6979 | 132.448 | -124582.0290 | 20244.1534 |
| 0048 | 0.7105 | 119.691 | -130476.6230 | 20618.3564 |

| | | | | |
|-------|--------|----------|--------------|------------|
| .0049 | 0.7218 | 106.370 | -135845.9565 | 20954.4121 |
| .0050 | 0.7317 | 92.540 | -140657.9435 | 21250.7281 |
| .0051 | 0.7403 | 78.258 | -144883.6041 | 21505.8750 |
| .0052 | 0.7474 | 63.340 | -151426.2989 | 21714.5941 |
| .0053 | 0.7529 | 48.038 | -154507.4530 | 21879.2240 |
| .0054 | 0.7570 | 32.462 | -156892.3735 | 21999.5143 |
| .0055 | 0.7594 | 16.683 | -158565.7154 | 22074.7594 |
| .0056 | 0.7603 | 0.773 | -159517.0549 | 22104.4576 |
| .0057 | 0.7596 | -15.196 | -159741.0144 | 22088.3146 |
| .0058 | 0.7573 | -31.151 | -159237.3281 | 22026.2451 |
| .0059 | 0.7534 | -47.019 | -158010.8499 | 21918.3729 |
| .0060 | 0.7479 | -62.729 | -156071.5010 | 21765.0298 |
| .0061 | 0.7408 | -78.210 | -153434.1580 | 21566.7529 |
| .0062 | 0.7322 | -93.162 | -147471.2222 | 21319.9332 |
| .0063 | 0.7222 | -107.726 | -143714.4449 | 21029.0775 |
| .0064 | 0.7107 | -121.885 | -139366.6713 | 20695.9032 |
| .0065 | 0.6978 | -135.581 | -134456.3385 | 20321.6694 |
| .0066 | 0.6836 | -148.758 | -129015.0754 | 19907.8019 |
| .0067 | 0.6681 | -161.367 | -123077.3796 | 19455.8828 |
| .0068 | 0.6514 | -173.358 | -116680.2698 | 18967.6414 |
| .0069 | 0.6334 | -184.689 | -109862.9175 | 18444.9428 |
| .0070 | 0.6144 | -195.318 | -102666.2647 | 17889.7766 |
| .0071 | 0.5944 | -205.105 | -93601.5407 | 17300.0299 |
| .0072 | 0.5734 | -214.092 | -86091.1128 | 16680.0410 |
| .0073 | 0.5516 | -222.315 | -78331.2161 | 16034.2637 |
| .0074 | 0.5290 | -229.751 | -70361.2523 | 15364.9948 |

MAXIMUM DEFLECTION

TIME

0.7603

0.0056

INPUT DATA FOR WINBLAST PROGRAM:

BLAST PRESSURE = 14.6 psi
 BLAST DURATION = 26 msec
 GLASS THICKNESS = 1.06 in.
 WINDOW SIZE = 72 x 72
 ASPECT RATIO = 1
 DAMPING PERCENTAGE = 0 %

| TIME (sec) | DISPLACEMENT (in) | VELOCITY (in/sec) | ACCELERATION (in/sec ²) | STRESS (psi) |
|---------------|----------------------|----------------------|--|-----------------|
| ----- | ----- | ----- | ----- | ----- |
| 0001 | 0.0000 | 0.500 | 9091.5741 | 0.2020 |
| 0002 | 0.0001 | 1.864 | 18177.3249 | 1.4764 |
| 0003 | 0.0004 | 4.135 | 27251.3936 | 5.0097 |
| 0004 | 0.0010 | 7.313 | 36307.9488 | 11.9888 |
| 0005 | 0.0019 | 11.396 | 45341.1699 | 23.5986 |
| 0006 | 0.0033 | 16.381 | 54345.2516 | 41.0211 |
| 0007 | 0.0052 | 22.264 | 63314.4073 | 65.4343 |
| 0008 | 0.0078 | 29.042 | 72242.8728 | 98.0119 |
| 0009 | 0.0111 | 36.711 | 81124.9100 | 139.9223 |
| 0010 | 0.0152 | 45.265 | 89954.8107 | 192.3279 |
| 0011 | 0.0201 | 54.227 | 89271.3390 | 256.2341 |
| 0012 | 0.0260 | 63.118 | 88530.4953 | 331.8260 |
| 0013 | 0.0327 | 71.931 | 87732.7558 | 419.0077 |
| 0014 | 0.0404 | 80.662 | 86878.6332 | 517.6755 |
| 0015 | 0.0489 | 89.305 | 85968.6763 | 627.7186 |
| 0016 | 0.0582 | 97.854 | 85003.4700 | 749.0185 |
| 0017 | 0.0684 | 106.304 | 83983.6346 | 881.4497 |
| 0018 | 0.0795 | 114.649 | 82909.8255 | 1024.8796 |
| 0019 | 0.0914 | 122.884 | 81782.7327 | 1179.1685 |
| 0020 | 0.1041 | 131.004 | 80603.0808 | 1344.1695 |
| 0021 | 0.1176 | 139.003 | 79371.6277 | 1519.7292 |
| 0022 | 0.1319 | 146.877 | 78089.1649 | 1705.6869 |
| 0023 | 0.1469 | 154.619 | 76756.5165 | 1901.8758 |
| 0024 | 0.1628 | 162.226 | 75374.5392 | 2108.1221 |
| 0025 | 0.1794 | 169.692 | 73944.1209 | 2324.2458 |
| 0026 | 0.1967 | 177.013 | 72466.1810 | 2550.0602 |
| 0027 | 0.2148 | 184.184 | 70941.6693 | 2785.3728 |
| 0028 | 0.2335 | 191.200 | 69371.5656 | 3029.9848 |
| 0029 | 0.2530 | 198.057 | 67756.8789 | 3283.6913 |
| 0030 | 0.2732 | 204.750 | 66098.6469 | 3546.2818 |
| 0031 | 0.2940 | 211.275 | 64397.9354 | 3817.5398 |
| 0032 | 0.3154 | 217.628 | 62655.8373 | 4097.2436 |
| 0033 | 0.3375 | 223.805 | 60873.4722 | 4385.1658 |
| 0034 | 0.3602 | 229.802 | 59051.9856 | 4681.0737 |
| 0035 | 0.3834 | 235.614 | 57192.5481 | 4984.7296 |
| 0036 | 0.4073 | 241.239 | 55296.3547 | 5295.8908 |
| 0037 | 0.4317 | 246.672 | 53364.6240 | 5614.3098 |
| 0038 | 0.4566 | 251.911 | 51398.5976 | 5939.7343 |
| 0039 | 0.4820 | 256.948 | 49257.1156 | 6276.1577 |
| 0040 | 0.5080 | 261.765 | 47076.7247 | 6629.5515 |
| 0041 | 0.5344 | 266.362 | 44851.7985 | 6989.4010 |
| 0042 | 0.5612 | 270.734 | 42583.3266 | 7355.4030 |
| 0043 | 0.5885 | 274.877 | 40272.3629 | 7727.2485 |
| 0044 | 0.6162 | 278.772 | 37697.7194 | 8105.9192 |
| 0045 | 0.6443 | 282.419 | 35249.8137 | 8490.3178 |
| 0046 | 0.6727 | 285.820 | 32759.4333 | 8879.5848 |
| 0047 | 0.7014 | 288.970 | 30227.9160 | 9273.3791 |
| 0048 | 0.7305 | 291.864 | 27656.6872 | 9671.3540 |

| | | | | |
|------|--------|---------|--------------|------------|
| 0049 | 0.7598 | 294.477 | 24672.4796 | 10072.5917 |
| 0050 | 0.7894 | 296.809 | 21948.9745 | 10476.8870 |
| 0051 | 0.8191 | 298.866 | 19186.2418 | 10884.2231 |
| 0052 | 0.8491 | 300.645 | 16386.1612 | 11294.2225 |
| 0053 | 0.8793 | 302.142 | 13550.7252 | 11706.5023 |
| 0054 | 0.9095 | 303.354 | 10682.0391 | 12120.6753 |
| 0055 | 0.9399 | 304.226 | 7132.5994 | 12532.3389 |
| 0056 | 0.9704 | 304.787 | 4091.4009 | 12944.4562 |
| 0057 | 1.0009 | 305.043 | 1019.9030 | 13357.1683 |
| 0058 | 1.0314 | 304.990 | -2079.0754 | 13770.0599 |
| 0059 | 1.0619 | 304.626 | -5202.5834 | 14182.7118 |
| 0060 | 1.0923 | 303.949 | -8347.5415 | 14594.7018 |
| 0061 | 1.1226 | 302.915 | -12465.0538 | 15001.6535 |
| 0062 | 1.1529 | 301.502 | -15781.9474 | 15402.3681 |
| 0063 | 1.1829 | 299.758 | -19113.1547 | 15801.0352 |
| 0064 | 1.2128 | 297.679 | -22454.6723 | 16197.2134 |
| 0065 | 1.2425 | 295.267 | -25802.3680 | 16590.4602 |
| 0066 | 1.2718 | 292.519 | -29151.9886 | 16980.3320 |
| 0067 | 1.3009 | 289.436 | -32499.1687 | 17366.3848 |
| 0068 | 1.3297 | 286.012 | -37235.1460 | 17748.7770 |
| 0069 | 1.3581 | 282.115 | -40715.5299 | 18139.7447 |
| 0070 | 1.3861 | 277.870 | -44179.9467 | 18525.1650 |
| 0071 | 1.4137 | 273.279 | -47623.0655 | 18904.5613 |
| 0072 | 1.4408 | 268.346 | -51039.4807 | 19277.4601 |
| 0073 | 1.4674 | 263.073 | -54423.7258 | 19643.3916 |
| 0074 | 1.4934 | 257.463 | -57770.2882 | 20001.8902 |
| 0075 | 1.5188 | 251.520 | -61073.6242 | 20352.4956 |
| 0076 | 1.5437 | 245.250 | -64328.1746 | 20694.7531 |
| 0077 | 1.5679 | 238.656 | -67528.3804 | 21028.2149 |
| 0078 | 1.5914 | 231.569 | -72821.0099 | 21370.4424 |
| 0079 | 1.6142 | 224.124 | -76055.9490 | 21706.3942 |
| 0080 | 1.6362 | 216.360 | -79214.4705 | 22031.2175 |
| 0081 | 1.6574 | 208.284 | -82290.4148 | 22344.4472 |
| 0082 | 1.6778 | 199.905 | -85277.7185 | 22645.6300 |
| 0083 | 1.6974 | 191.232 | -88170.4349 | 22934.3257 |
| 0084 | 1.7161 | 182.274 | -90962.7540 | 23210.1078 |
| 0085 | 1.7339 | 173.043 | -93649.0221 | 23472.5646 |
| 0086 | 1.7507 | 163.548 | -96223.7618 | 23721.2998 |
| 0087 | 1.7666 | 153.802 | -98681.6905 | 23955.9334 |
| 0088 | 1.7814 | 143.816 | -101017.7393 | 24176.1026 |
| 0089 | 1.7953 | 133.603 | -103227.0708 | 24381.4623 |
| 0090 | 1.8082 | 123.175 | -105305.0962 | 24571.6860 |
| 0091 | 1.8199 | 112.546 | -107247.4918 | 24746.4664 |
| 0092 | 1.8307 | 101.730 | -109050.2150 | 24905.5162 |
| 0093 | 1.8403 | 90.697 | -113629.0580 | 25049.8356 |
| 0094 | 1.8488 | 79.254 | -115207.5934 | 25186.1992 |
| 0095 | 1.8561 | 67.661 | -116623.2051 | 25304.3493 |
| 0096 | 1.8623 | 55.935 | -117872.7712 | 25404.0593 |
| 0097 | 1.8673 | 44.092 | -118953.5723 | 25485.1286 |
| 0098 | 1.8711 | 32.150 | -119863.3038 | 25547.3835 |
| 0099 | 1.8737 | 20.125 | -120600.0842 | 25590.6773 |
| 0100 | 1.8751 | 8.036 | -121162.4638 | 25614.8905 |
| 0101 | 1.8753 | -4.101 | -121549.4304 | 25619.9315 |
| 0102 | 1.8743 | -16.268 | -121760.4145 | 25605.7362 |
| 0103 | 1.8721 | -28.447 | -121795.2914 | 25572.2683 |
| 0104 | 1.8686 | -40.621 | -121654.3830 | 25519.5196 |
| 0105 | 1.8640 | -52.772 | -121338.4570 | 25447.5096 |
| 0106 | 1.8581 | -64.883 | -120848.7244 | 25356.2855 |
| 0107 | 1.8510 | -76.936 | -120186.8361 | 25245.9221 |
| 0108 | 1.8427 | -88.915 | -119354.8766 | 25116.5214 |

| | | | | |
|-------|--------|----------|--------------|------------|
| .0109 | 1.8332 | -100.672 | -115480.0560 | 24972.8321 |
| .0110 | 1.8226 | -112.167 | -114402.8445 | 24818.1259 |
| .0111 | 1.8108 | -123.547 | -113176.5863 | 24646.5931 |
| .0112 | 1.7979 | -134.797 | -111804.5064 | 24458.4119 |
| .0113 | 1.7838 | -145.903 | -110290.1577 | 24253.7817 |
| .0114 | 1.7687 | -156.851 | -108637.4098 | 24032.9229 |
| .0115 | 1.7525 | -167.626 | -106850.4352 | 23796.0762 |
| .0116 | 1.7352 | -178.216 | -104933.6957 | 23543.5024 |
| .0117 | 1.7168 | -188.609 | -102891.9270 | 23275.4812 |
| .0118 | 1.6975 | -198.791 | -100730.1227 | 22992.3106 |
| .0119 | 1.6771 | -208.751 | -98453.5178 | 22694.3066 |
| .0120 | 1.6557 | -218.478 | -96067.5712 | 22381.8021 |
| .0121 | 1.6334 | -227.961 | -93577.9473 | 22055.1459 |
| .0122 | 1.6101 | -237.190 | -90990.4972 | 21714.7025 |
| .0123 | 1.5860 | -246.156 | -88311.2399 | 21360.8504 |
| .0124 | 1.5609 | -254.800 | -83578.8436 | 21000.2868 |
| .0125 | 1.5350 | -263.025 | -80911.9728 | 20645.5593 |
| .0126 | 1.5083 | -270.980 | -78175.7920 | 20279.6756 |
| .0127 | 1.4808 | -278.658 | -75375.9196 | 19903.0108 |
| .0128 | 1.4526 | -286.053 | -72518.0368 | 19515.9487 |
| .0129 | 1.4236 | -293.160 | -69607.8707 | 19118.8813 |
| .0130 | 1.3940 | -299.973 | -66651.1783 | 18712.2078 |
| .0131 | 1.3636 | -306.489 | -63653.7297 | 18296.3339 |
| .0132 | 1.3327 | -312.703 | -60621.2924 | 17871.6709 |
| .0133 | 1.3011 | -318.526 | -56287.1321 | 17449.1410 |
| .0134 | 1.2690 | -324.009 | -53364.5838 | 17024.0872 |
| .0135 | 1.2363 | -329.198 | -50422.4173 | 16591.9228 |
| .0136 | 1.2032 | -334.093 | -47465.5384 | 16153.0373 |
| .0137 | 1.1695 | -338.691 | -44498.7916 | 15707.8225 |
| .0138 | 1.1354 | -342.992 | -41526.9486 | 15256.6713 |
| .0139 | 1.1009 | -346.992 | -37673.8766 | 14799.6114 |
| .0140 | 1.0660 | -350.618 | -34854.1731 | 14327.9517 |
| .0141 | 1.0308 | -353.963 | -32038.6214 | 13851.5359 |
| .0142 | 0.9953 | -357.026 | -29231.0407 | 13370.7454 |
| .0143 | 0.9594 | -359.809 | -26435.1522 | 12885.9603 |
| .0144 | 0.9233 | -362.314 | -23654.5727 | 12397.5592 |
| .0145 | 0.8870 | -364.513 | -20407.7693 | 11902.9923 |
| .0146 | 0.8504 | -366.422 | -17784.5056 | 11403.0861 |
| .0147 | 0.8137 | -368.070 | -15180.4699 | 10900.7100 |
| .0148 | 0.7768 | -369.459 | -12598.4337 | 10396.2207 |
| .0149 | 0.7398 | -370.591 | -10041.0638 | 9889.9719 |
| .0150 | 0.7027 | -371.444 | -7259.7676 | 9381.3029 |
| .0151 | 0.6655 | -372.048 | -4839.5295 | 8871.4627 |
| .0152 | 0.6283 | -372.412 | -2444.7585 | 8360.9253 |
| .0153 | 0.5910 | -372.538 | -77.4763 | 7850.0196 |
| .0154 | 0.5538 | -372.414 | 2384.7116 | 7341.4677 |
| .0155 | 0.5166 | -372.063 | 4636.4221 | 6833.2802 |
| .0156 | 0.4794 | -371.488 | 6860.8635 | 6325.6948 |
| .0157 | 0.4423 | -370.689 | 9036.8814 | 5833.8430 |
| .0158 | 0.4053 | -369.684 | 11052.4775 | 5349.4631 |
| .0159 | 0.3684 | -368.478 | 13060.9706 | 4866.5025 |
| .0160 | 0.3316 | -367.072 | 15061.0698 | 4385.2241 |
| .0161 | 0.2949 | -365.466 | 17051.4896 | 3905.8895 |
| .0162 | 0.2585 | -363.662 | 19030.9511 | 3428.7593 |
| .0163 | 0.2222 | -361.661 | 20998.1819 | 2954.0925 |
| .0164 | 0.1862 | -359.463 | 22951.9178 | 2482.1466 |
| .0165 | 0.1503 | -357.071 | 24890.9032 | 2013.1773 |
| .0166 | 0.1148 | -354.485 | 26813.8920 | 1547.4385 |
| .0167 | 0.0794 | -351.709 | 28719.6484 | 1085.1818 |
| .0168 | 0.0444 | -348.742 | 30606.9475 | 626.6569 |

| | | | | |
|------|---------|----------|------------|-------------|
| 0169 | 0.0097 | -345.588 | 32474.5764 | 172.1107 |
| 0170 | -0.0247 | -342.248 | 34321.3350 | -278.2121 |
| 0171 | -0.0587 | -338.724 | 36146.0362 | -724.0697 |
| 0172 | -0.0924 | -335.019 | 37947.5076 | -1165.2231 |
| 0173 | -0.1257 | -331.136 | 39724.5912 | -1601.4365 |
| 0174 | -0.1587 | -327.075 | 41476.1451 | -2032.4770 |
| 0175 | -0.1912 | -322.841 | 43201.0435 | -2458.1153 |
| 0176 | -0.2232 | -318.436 | 44898.1779 | -2878.1252 |
| 0177 | -0.2548 | -313.863 | 46566.4576 | -3292.2845 |
| 0178 | -0.2860 | -309.124 | 48204.8106 | -3700.3746 |
| 0179 | -0.3167 | -304.223 | 49812.1837 | -4102.1808 |
| 0180 | -0.3468 | -299.162 | 51387.5441 | -4497.4924 |
| 0181 | -0.3765 | -293.946 | 52929.8793 | -4886.1030 |
| 0182 | -0.4056 | -288.578 | 54438.1981 | -5267.8103 |
| 0183 | -0.4342 | -283.060 | 55911.5311 | -5642.4167 |
| 0184 | -0.4622 | -277.397 | 57348.9315 | -6009.7290 |
| 0185 | -0.4897 | -271.584 | 58912.9840 | -6378.0595 |
| 0186 | -0.5165 | -265.618 | 60397.5410 | -6745.5372 |
| 0187 | -0.5428 | -259.505 | 61852.8218 | -7104.7909 |
| 0188 | -0.5684 | -253.249 | 63276.9452 | -7455.6215 |
| 0189 | -0.5934 | -246.851 | 64668.0508 | -7797.8343 |
| 0190 | -0.6178 | -240.299 | 66242.0326 | -8132.6624 |
| 0191 | -0.6415 | -233.607 | 67599.6255 | -8458.6062 |
| 0192 | -0.6645 | -226.780 | 68919.7049 | -8775.2967 |
| 0193 | -0.6868 | -219.824 | 70200.2717 | -9082.5523 |
| 0194 | -0.7085 | -212.742 | 71439.3670 | -9380.1968 |
| 0195 | -0.7294 | -205.538 | 72635.0763 | -9668.0597 |
| 0196 | -0.7496 | -198.201 | 74134.8009 | -9945.7056 |
| 0197 | -0.7690 | -190.730 | 75284.5362 | -10212.8649 |
| 0198 | -0.7877 | -183.146 | 76385.0739 | -10469.7375 |
| 0199 | -0.8056 | -175.454 | 77434.4355 | -10716.1722 |
| 0200 | -0.8228 | -167.661 | 78430.7136 | -10952.0247 |
| 0201 | -0.8392 | -159.770 | 79372.0754 | -11177.1580 |
| 0202 | -0.8547 | -151.788 | 80256.7671 | -11391.4424 |
| 0203 | -0.8695 | -143.721 | 81083.1176 | -11594.7561 |
| 0204 | -0.8835 | -135.574 | 81849.5421 | -11786.9854 |
| 0205 | -0.8966 | -127.353 | 82554.5458 | -11968.0244 |
| 0206 | -0.9090 | -119.065 | 83196.7269 | -12137.7758 |
| 0207 | -0.9204 | -110.673 | 84356.5510 | -12294.7719 |
| 0208 | -0.9311 | -102.209 | 84903.1218 | -12439.9954 |
| 0209 | -0.9409 | -93.695 | 85380.5634 | -12573.7348 |
| 0210 | -0.9498 | -85.136 | 85787.6959 | -12695.9244 |
| 0211 | -0.9579 | -76.540 | 86123.4623 | -12806.5083 |
| 0212 | -0.9651 | -67.913 | 86386.9303 | -12905.4399 |
| 0213 | -0.9715 | -59.265 | 86577.2945 | -12992.6827 |
| 0214 | -0.9770 | -50.600 | 86693.8783 | -13068.2098 |
| 0215 | -0.9816 | -41.928 | 86736.1348 | -13132.0046 |
| 0216 | -0.9854 | -33.256 | 86703.6483 | -13184.0604 |
| 0217 | -0.9883 | -24.590 | 86596.1350 | -13224.3804 |
| 0218 | -0.9903 | -15.939 | 86413.4429 | -13252.9782 |
| 0219 | -0.9915 | -7.310 | 86155.5523 | -13269.8776 |
| 0220 | -0.9918 | 1.290 | 85822.5751 | -13275.1124 |
| 0221 | -0.9912 | 9.852 | 85414.7546 | -13268.7266 |
| 0222 | -0.9898 | 18.370 | 84932.4638 | -13250.7746 |
| 0223 | -0.9875 | 26.836 | 84376.2049 | -13221.3205 |
| 0224 | -0.9844 | 35.243 | 83746.6070 | -13180.4385 |
| 0225 | -0.9805 | 43.583 | 83044.4241 | -13128.2131 |
| 0226 | -0.9757 | 51.849 | 82270.5331 | -13064.7381 |
| 0227 | -0.9701 | 60.035 | 81425.9312 | -12990.1174 |
| 0228 | -0.9637 | 68.132 | 80511.7326 | -12904.4644 |

| | | | | |
|------|---------|---------|-------------|-------------|
| 0229 | -0.9565 | 76.135 | 79529.1653 | -12807.9017 |
| 0230 | -0.9485 | 84.036 | 78479.5680 | -12700.5616 |
| 0231 | -0.9397 | 91.829 | 77364.3859 | -12582.5850 |
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| 0239 | -0.8426 | 149.302 | 65939.4279 | -11266.5575 |
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| 0503 | -0.2648 | 260.385 | 17017.8948 | -3497.6207 |
| 0504 | -0.2387 | 262.003 | 15339.0993 | -3156.1561 |
| 0505 | -0.2124 | 263.453 | 13650.4459 | -2812.6631 |
| 0506 | -0.1860 | 264.733 | 11953.0197 | -2467.3626 |
| 0507 | -0.1594 | 265.843 | 10247.9117 | -2120.4763 |
| 0508 | -0.1328 | 266.782 | 8536.2176 | -1772.2273 |
| 0509 | -0.1061 | 267.550 | 6819.0376 | -1422.8393 |
| 0510 | -0.0793 | 268.146 | 5097.4752 | -1072.5369 |
| 0511 | -0.0525 | 268.569 | 3372.6369 | -721.5452 |
| 0512 | -0.0256 | 268.820 | 1645.6310 | -370.0899 |
| 0513 | 0.0013 | 268.899 | -82.4325 | -18.3966 |
| 0514 | 0.0282 | 268.804 | -1810.4430 | 333.3085 |
| 0515 | 0.0550 | 268.537 | -3537.2899 | 684.7993 |
| 0516 | 0.0819 | 268.097 | -5261.8636 | 1035.8501 |
| 0517 | 0.1087 | 267.484 | -6983.0556 | 1386.2351 |
| 0518 | 0.1354 | 266.700 | -8699.7599 | 1735.7293 |
| 0519 | 0.1620 | 265.745 | -10410.8730 | 2084.1079 |
| 0520 | 0.1885 | 264.618 | -12115.2954 | 2431.1472 |
| 0521 | 0.2149 | 263.322 | -13811.9317 | 2776.6240 |
| 0522 | 0.2412 | 261.856 | -15499.6915 | 3120.3164 |
| 0523 | 0.2673 | 260.222 | -17177.4901 | 3462.0035 |
| 0524 | 0.2932 | 258.421 | -18844.2493 | 3801.4656 |
| 0525 | 0.3189 | 256.454 | -20498.8978 | 4138.4847 |
| 0526 | 0.3445 | 254.322 | -22140.3723 | 4472.8441 |
| 0527 | 0.3698 | 252.026 | -23767.6179 | 4804.3289 |
| 0528 | 0.3949 | 249.569 | -25379.5888 | 5132.7261 |

| | | | | |
|------|--------|----------|-------------|------------|
| 0529 | 0.4197 | 246.951 | -26975.2490 | 5457.8247 |
| 0530 | 0.4443 | 244.174 | -28553.5730 | 5779.4157 |
| 0531 | 0.4685 | 241.241 | -30113.5465 | 6097.2924 |
| 0532 | 0.4925 | 238.141 | -31837.7460 | 6421.5650 |
| 0533 | 0.5162 | 234.876 | -33473.9384 | 6744.8685 |
| 0534 | 0.5395 | 231.447 | -35096.3961 | 7063.6251 |
| 0535 | 0.5625 | 227.857 | -36703.5538 | 7377.6132 |
| 0536 | 0.5851 | 224.107 | -38293.8398 | 7686.6132 |
| 0537 | 0.6073 | 220.188 | -40068.5506 | 7991.1550 |
| 0538 | 0.6291 | 216.102 | -41656.3425 | 8290.9463 |
| 0539 | 0.6505 | 211.858 | -43223.5106 | 8585.0457 |
| 0540 | 0.6714 | 207.458 | -44768.3096 | 8873.2381 |
| 0541 | 0.6920 | 202.905 | -46288.9984 | 9155.3113 |
| 0542 | 0.7120 | 198.201 | -47783.8433 | 9431.0563 |
| 0543 | 0.7316 | 193.349 | -49251.1212 | 9700.2679 |
| 0544 | 0.7507 | 188.333 | -51041.6003 | 9962.4332 |
| 0545 | 0.7693 | 183.156 | -52493.6385 | 10217.3471 |
| 0546 | 0.7873 | 177.835 | -53913.0301 | 10465.0974 |
| 0547 | 0.8048 | 172.374 | -55297.9091 | 10705.4892 |
| 0548 | 0.8218 | 166.777 | -56646.4375 | 10938.3328 |
| 0549 | 0.8382 | 161.046 | -57956.8099 | 11163.4429 |
| 0550 | 0.8540 | 155.187 | -59227.2571 | 11380.6399 |
| 0551 | 0.8692 | 149.202 | -60456.0499 | 11589.7493 |
| 0552 | 0.8838 | 143.097 | -61641.5030 | 11790.6024 |
| 0553 | 0.8978 | 136.876 | -62781.9789 | 11983.0363 |
| 0554 | 0.9112 | 130.542 | -63875.8915 | 12166.8944 |
| 0555 | 0.9239 | 124.047 | -65515.1495 | 12340.1343 |
| 0556 | 0.9360 | 117.444 | -66550.8546 | 12504.4729 |
| 0557 | 0.9474 | 110.739 | -67533.5391 | 12659.8177 |
| 0558 | 0.9581 | 103.939 | -68461.6682 | 12806.0353 |
| 0559 | 0.9682 | 97.049 | -69333.7850 | 12942.9992 |
| 0560 | 0.9776 | 90.074 | -70148.5138 | 13070.5906 |
| 0561 | 0.9862 | 83.021 | -70904.5636 | 13188.6985 |
| 0562 | 0.9942 | 75.895 | -71600.7317 | 13297.2197 |
| 0563 | 1.0014 | 68.703 | -72235.9060 | 13396.0592 |
| 0564 | 1.0079 | 61.450 | -72809.0686 | 13485.1303 |
| 0565 | 1.0137 | 54.143 | -73319.2978 | 13564.3545 |
| 0566 | 1.0187 | 46.788 | -73765.7707 | 13633.6619 |
| 0567 | 1.0230 | 39.392 | -74147.7653 | 13692.9912 |
| 0568 | 1.0266 | 31.961 | -74464.6621 | 13742.2898 |
| 0569 | 1.0294 | 24.501 | -74715.9460 | 13781.5140 |
| 0570 | 1.0315 | 17.020 | -74901.2076 | 13810.6288 |
| 0571 | 1.0328 | 9.523 | -75020.1438 | 13829.6084 |
| 0572 | 1.0334 | 2.018 | -75072.5591 | 13838.4356 |
| 0573 | 1.0332 | -5.489 | -75058.3661 | 13837.1026 |
| 0574 | 1.0323 | -12.991 | -74977.5854 | 13825.6103 |
| 0575 | 1.0306 | -20.482 | -74830.3455 | 13803.9687 |
| 0576 | 1.0282 | -27.955 | -74616.8831 | 13772.1970 |
| 0577 | 1.0250 | -35.403 | -74337.5417 | 13730.3230 |
| 0578 | 1.0211 | -42.821 | -73992.7713 | 13678.3837 |
| 0579 | 1.0165 | -50.200 | -73583.1271 | 13616.4249 |
| 0580 | 1.0111 | -57.535 | -73109.2678 | 13544.5011 |
| 0581 | 1.0050 | -64.820 | -72571.9543 | 13462.6757 |
| 0582 | 0.9981 | -72.047 | -71972.0479 | 13371.0204 |
| 0583 | 0.9906 | -79.212 | -71310.5074 | 13269.6156 |
| 0584 | 0.9823 | -86.307 | -70588.3875 | 13158.5500 |
| 0585 | 0.9733 | -93.328 | -69806.8355 | 13037.9206 |
| 0586 | 0.9636 | -100.267 | -68967.0889 | 12907.8323 |
| 0587 | 0.9533 | -107.119 | -68070.4719 | 12768.3979 |
| 0588 | 0.9422 | -113.879 | -67118.3925 | 12619.7382 |

| | | | | |
|-------|--------|----------|-------------|------------|
| .0589 | 0.9305 | -120.541 | -66112.3387 | 12461.9811 |
| .0590 | 0.9181 | -127.100 | -65053.8748 | 12295.2621 |
| .0591 | 0.9051 | -133.536 | -63405.2631 | 12119.1533 |
| .0592 | 0.8914 | -139.822 | -62290.2277 | 11932.9571 |
| .0593 | 0.8771 | -145.993 | -61129.2468 | 11738.2216 |
| .0594 | 0.8622 | -152.046 | -59923.9284 | 11535.1049 |
| .0595 | 0.8467 | -157.976 | -58675.9306 | 11323.7714 |
| .0596 | 0.8306 | -163.780 | -57386.9577 | 11104.3913 |
| .0597 | 0.8140 | -169.452 | -56058.7566 | 10877.1404 |
| .0598 | 0.7967 | -174.990 | -54693.1129 | 10642.1999 |
| .0599 | 0.7790 | -180.390 | -53291.8471 | 10399.7562 |
| .0600 | 0.7607 | -185.648 | -51856.8105 | 10150.0006 |

| MAXIMUM DEFLECTION | TIME |
|--------------------|--------|
| ----- | ---- |
| 1.8754 | 0.0101 |

INPUT DATA FOR WINBLAST PROGRAM:

BLAST PRESSURE = 30 psi
 BLAST DURATION = 26 msec
 GLASS THICKNESS = 1.06 in.
 WINDOW SIZE = 72 x 72
 ASPECT RATIO = 1
 DAMPING PERCENTAGE = 0 %

| TIME (sec) | DISPLACEMENT (in) | VELOCITY (in/sec) | ACCELERATION (in/sec ²) | STRESS (psi) |
|---------------|----------------------|----------------------|--|-----------------|
| ----- | ----- | ----- | ----- | ----- |
| 0.0001 | 0.0000 | 1.028 | 18681.3167 | 0.4151 |
| 0.0002 | 0.0003 | 3.829 | 37350.6676 | 3.0338 |
| 0.0003 | 0.0009 | 8.497 | 55996.0143 | 10.2939 |
| 0.0004 | 0.0020 | 15.027 | 74605.3741 | 24.6345 |
| 0.0005 | 0.0039 | 23.416 | 93166.7874 | 48.4904 |
| 0.0006 | 0.0068 | 33.659 | 111668.3252 | 84.2899 |
| 0.0007 | 0.0107 | 45.748 | 130098.0972 | 134.4540 |
| 0.0008 | 0.0160 | 59.675 | 148444.2591 | 201.3943 |
| 0.0009 | 0.0227 | 75.433 | 166695.0205 | 287.5116 |
| 0.0010 | 0.0311 | 93.011 | 184838.6521 | 395.1943 |
| 0.0011 | 0.0414 | 111.425 | 183434.2581 | 526.5084 |
| 0.0012 | 0.0534 | 129.694 | 181911.9767 | 681.8343 |
| 0.0013 | 0.0673 | 147.804 | 180272.7859 | 860.9747 |
| 0.0014 | 0.0830 | 165.744 | 178517.7394 | 1063.7168 |
| 0.0015 | 0.1004 | 183.504 | 176647.9650 | 1289.8326 |
| 0.0016 | 0.1197 | 201.070 | 174664.6644 | 1539.0790 |
| 0.0017 | 0.1406 | 218.433 | 172569.1122 | 1811.1980 |
| 0.0018 | 0.1633 | 235.580 | 170362.6551 | 2105.9171 |
| 0.0019 | 0.1877 | 252.502 | 168046.7111 | 2422.9490 |
| 0.0020 | 0.2138 | 269.186 | 165622.7687 | 2761.9922 |
| 0.0021 | 0.2416 | 285.623 | 163092.3856 | 3122.7311 |
| 0.0022 | 0.2710 | 301.801 | 160457.1881 | 3504.8362 |
| 0.0023 | 0.3019 | 317.711 | 157718.8696 | 3907.9640 |
| 0.0024 | 0.3345 | 333.341 | 154879.1901 | 4331.7578 |
| 0.0025 | 0.3686 | 348.683 | 151939.9744 | 4775.8475 |
| 0.0026 | 0.4042 | 363.726 | 148903.1116 | 5239.8498 |
| 0.0027 | 0.4413 | 378.461 | 145770.5534 | 5723.3688 |
| 0.0028 | 0.4799 | 392.875 | 142416.1770 | 6228.2471 |
| 0.0029 | 0.5199 | 406.938 | 138817.0009 | 6772.2491 |
| 0.0030 | 0.5613 | 420.635 | 135091.0894 | 7335.2485 |
| 0.0031 | 0.6040 | 433.949 | 131039.7658 | 7917.1318 |
| 0.0032 | 0.6480 | 446.850 | 126959.5952 | 8519.4708 |
| 0.0033 | 0.6934 | 459.337 | 122742.8384 | 9139.2792 |
| 0.0034 | 0.7399 | 471.394 | 118389.5656 | 9775.9804 |
| 0.0035 | 0.7876 | 482.973 | 113449.1202 | 10427.5893 |
| 0.0036 | 0.8365 | 494.081 | 108679.9020 | 11094.6661 |
| 0.0037 | 0.8864 | 504.704 | 103761.8259 | 11776.6800 |
| 0.0038 | 0.9374 | 514.801 | 98053.2205 | 12469.6603 |
| 0.0039 | 0.9894 | 524.337 | 92626.6028 | 13171.6834 |
| 0.0040 | 1.0422 | 533.321 | 87038.2138 | 13886.3165 |
| 0.0041 | 1.0960 | 541.739 | 81289.9392 | 14612.8053 |
| 0.0042 | 1.1506 | 549.500 | 74297.5394 | 15339.1912 |
| 0.0043 | 1.2059 | 556.614 | 67954.4069 | 16071.2368 |
| 0.0044 | 1.2619 | 563.085 | 61442.7420 | 16812.3710 |
| 0.0045 | 1.3185 | 568.897 | 54766.9932 | 17561.7333 |
| 0.0046 | 1.3756 | 573.919 | 46293.9560 | 18340.1293 |
| 0.0047 | 1.4332 | 578.184 | 38973.0964 | 19131.3027 |
| 0.0048 | 1.4912 | 581.708 | 31489.3376 | 19927.9321 |

| | | | | |
|-------|--------|----------|--------------|------------|
| .0049 | 1.5496 | 584.477 | 23850.8378 | 20728.9911 |
| .0050 | 1.6081 | 586.356 | 13805.6486 | 21564.0224 |
| .0051 | 1.6668 | 587.319 | 5441.1697 | 22426.3352 |
| .0052 | 1.7255 | 587.439 | -3063.8801 | 23289.5697 |
| .0053 | 1.7843 | 586.702 | -11696.3856 | 24152.4783 |
| .0054 | 1.8429 | 585.096 | -20442.3325 | 25013.7942 |
| .0055 | 1.9012 | 582.310 | -32676.4990 | 25937.0489 |
| .0056 | 1.9593 | 578.573 | -42094.9118 | 26856.7050 |
| .0057 | 2.0169 | 573.889 | -51587.0164 | 27769.8453 |
| .0058 | 2.0740 | 568.253 | -61133.0681 | 28674.9684 |
| .0059 | 2.1305 | 561.661 | -70712.5297 | 29570.5639 |
| .0060 | 2.1863 | 553.747 | -84804.9210 | 30680.2079 |
| .0061 | 2.2412 | 544.761 | -94921.6284 | 31803.1712 |
| .0062 | 2.2952 | 534.764 | -105004.3657 | 32906.9688 |
| .0063 | 2.3482 | 523.762 | -115026.8978 | 33989.5425 |
| .0064 | 2.4000 | 511.761 | -124962.5368 | 35048.8457 |
| .0065 | 2.4505 | 498.773 | -134784.2585 | 36082.8492 |
| .0066 | 2.4997 | 484.336 | -150255.9623 | 37266.0174 |
| .0067 | 2.5473 | 468.807 | -160295.6348 | 38442.4244 |
| .0068 | 2.5934 | 452.284 | -170121.4154 | 39579.6470 |
| .0069 | 2.6377 | 434.791 | -179702.3491 | 40675.2628 |
| .0070 | 2.6803 | 416.353 | -189007.8118 | 41726.9093 |
| .0071 | 2.7210 | 397.000 | -198007.6660 | 42732.2907 |
| .0072 | 2.7597 | 376.763 | -206672.4162 | 43689.1858 |
| .0073 | 2.7963 | 355.678 | -214973.3616 | 44595.4550 |
| .0074 | 2.8308 | 333.312 | -230242.3509 | 45525.2404 |
| .0075 | 2.8629 | 309.890 | -238120.9793 | 46431.5938 |
| .0076 | 2.8927 | 285.704 | -245515.1291 | 47271.5623 |
| .0077 | 2.9201 | 260.804 | -252397.5229 | 48043.0643 |
| .0078 | 2.9449 | 235.242 | -258742.6488 | 48744.1603 |
| .0079 | 2.9671 | 209.074 | -264526.9101 | 49373.0607 |
| .0080 | 2.9867 | 182.356 | -269728.7651 | 49928.1319 |
| .0081 | 3.0035 | 155.148 | -274328.8553 | 50407.9028 |
| .0082 | 3.0177 | 127.511 | -278310.1220 | 50811.0699 |
| .0083 | 3.0290 | 99.508 | -281657.9093 | 51136.5023 |
| .0084 | 3.0376 | 71.201 | -284360.0533 | 51383.2460 |
| .0085 | 3.0433 | 42.658 | -286406.9578 | 51550.5270 |
| .0086 | 3.0461 | 13.942 | -287791.6538 | 51637.7546 |
| .0087 | 3.0460 | -14.878 | -288509.8452 | 51644.5230 |
| .0088 | 3.0431 | -43.737 | -288559.9378 | 51570.6125 |
| .0089 | 3.0373 | -72.568 | -287943.0530 | 51415.9904 |
| .0090 | 3.0286 | -101.304 | -286663.0254 | 51180.8107 |

MAXIMUM DEFLECTION

TIME

3.0464

0.0086

INPUT DATA FOR WINBLAST PROGRAM:

BLAST PRESSURE = 40 psi
 BLAST DURATION = 26 msec
 GLASS THICKNESS = 1.06 in.
 WINDOW SIZE = 72 x 72
 ASPECT RATIO = 1
 DAMPING PERCENTAGE = 0 %

| TIME (sec) | DISPLACEMENT (in) | VELOCITY (in/sec) | ACCELERATION (in/sec2) | STRESS (psi) |
|---------------|----------------------|----------------------|---------------------------|-----------------|
| ----- | ----- | ----- | ----- | ----- |
| 0001 | 0.0001 | 1.370 | 24908.4223 | 0.5534 |
| 0002 | 0.0004 | 5.106 | 49800.8901 | 4.0450 |
| 0003 | 0.0012 | 11.329 | 74661.3524 | 13.7252 |
| 0004 | 0.0027 | 20.036 | 99473.8322 | 32.8460 |
| 0005 | 0.0052 | 31.222 | 124222.3832 | 64.6538 |
| 0006 | 0.0090 | 44.878 | 148891.1002 | 112.3866 |
| 0007 | 0.0143 | 60.997 | 173464.1295 | 179.2720 |
| 0008 | 0.0213 | 79.567 | 197925.6788 | 268.5257 |
| 0009 | 0.0303 | 100.578 | 222260.0273 | 383.3487 |
| 0010 | 0.0415 | 124.014 | 246451.5361 | 526.9258 |
| 0011 | 0.0551 | 148.567 | 244579.0108 | 702.0112 |
| 0012 | 0.0712 | 172.925 | 242549.3022 | 909.1124 |
| 0013 | 0.0897 | 197.072 | 240363.7146 | 1147.9663 |
| 0014 | 0.1106 | 220.993 | 238023.6525 | 1418.2891 |
| 0015 | 0.1339 | 244.672 | 235530.6200 | 1719.7769 |
| 0016 | 0.1596 | 268.094 | 232886.2192 | 2052.1054 |
| 0017 | 0.1875 | 291.244 | 230092.1496 | 2414.9307 |
| 0018 | 0.2178 | 314.107 | 227150.2068 | 2807.8894 |
| 0019 | 0.2503 | 336.669 | 224062.2815 | 3230.5986 |
| 0020 | 0.2851 | 358.915 | 220830.3583 | 3682.6563 |
| 0021 | 0.3221 | 380.830 | 217456.5142 | 4163.6415 |
| 0022 | 0.3613 | 402.401 | 213942.9174 | 4673.1149 |
| 0023 | 0.4026 | 423.614 | 210291.8262 | 5210.6187 |
| 0024 | 0.4460 | 444.455 | 206505.5868 | 5775.6771 |
| 0025 | 0.4914 | 464.906 | 202372.5564 | 6376.2219 |
| 0026 | 0.5389 | 484.923 | 197940.4091 | 7021.8069 |
| 0027 | 0.5884 | 504.487 | 193325.9159 | 7694.4708 |
| 0028 | 0.6398 | 523.564 | 188240.2069 | 8396.2798 |
| 0029 | 0.6931 | 542.133 | 183116.2406 | 9124.6578 |
| 0030 | 0.7482 | 560.179 | 177450.4330 | 9878.1086 |
| 0031 | 0.8051 | 577.641 | 171758.8753 | 10654.3289 |
| 0032 | 0.8637 | 594.523 | 165844.3379 | 11454.1310 |
| 0033 | 0.9240 | 610.794 | 159117.3553 | 12275.5579 |
| 0034 | 0.9859 | 626.376 | 152486.8240 | 13110.7971 |
| 0035 | 1.0493 | 641.283 | 145606.1028 | 13966.7643 |
| 0036 | 1.1141 | 655.484 | 137571.0536 | 14841.9998 |
| 0037 | 1.1803 | 668.857 | 129846.9225 | 15717.8301 |
| 0038 | 1.2479 | 681.444 | 121846.7625 | 16610.9691 |
| 0039 | 1.3166 | 693.218 | 113572.8744 | 17520.3601 |
| 0040 | 1.3865 | 704.034 | 103328.3161 | 18471.2839 |
| 0041 | 1.4574 | 713.907 | 94094.5816 | 19444.3802 |
| 0042 | 1.5292 | 722.843 | 84572.9219 | 20430.5336 |
| 0043 | 1.6019 | 730.738 | 72560.0792 | 21451.7800 |
| 0044 | 1.6753 | 737.465 | 61916.3980 | 22529.6764 |
| 0045 | 1.7494 | 743.112 | 50982.2568 | 23616.8261 |
| 0046 | 1.8239 | 747.652 | 39771.4150 | 24711.6267 |
| 0047 | 1.8988 | 750.823 | 24934.8518 | 25872.6975 |
| 0048 | 1.9740 | 752.700 | 12570.7033 | 27062.7326 |

| | | | | |
|------|--------|----------|--------------|------------|
| 0049 | 2.0493 | 753.328 | -42.0583 | 28254.9522 |
| 0050 | 2.1247 | 752.684 | -12880.1087 | 29447.3633 |
| 0051 | 2.1998 | 750.379 | -30537.6623 | 30915.8833 |
| 0052 | 2.2747 | 746.629 | -44491.7485 | 32444.4879 |
| 0053 | 2.3491 | 741.476 | -58607.1429 | 33964.2958 |
| 0054 | 2.4229 | 734.904 | -72849.5617 | 35472.4297 |
| 0055 | 2.4960 | 726.653 | -92916.7308 | 37117.3759 |
| 0056 | 2.5682 | 716.601 | -108119.9703 | 38895.3841 |
| 0057 | 2.6393 | 705.028 | -123341.4012 | 40647.1680 |
| 0058 | 2.7092 | 691.934 | -138535.4061 | 42368.9842 |
| 0059 | 2.7776 | 677.323 | -153655.1959 | 44057.0944 |
| 0060 | 2.8446 | 660.878 | -176152.2217 | 45819.6236 |
| 0061 | 2.9098 | 642.479 | -191790.1635 | 47648.0834 |
| 0062 | 2.9730 | 622.527 | -207190.2419 | 49423.3329 |
| 0063 | 3.0342 | 601.050 | -222296.6181 | 51141.0583 |
| 0064 | 3.0932 | 578.080 | -237053.5188 | 52797.0262 |
| 0065 | 3.1498 | 553.653 | -251405.5609 | 54387.0992 |
| 0066 | 3.2039 | 527.680 | -274317.5722 | 55932.9557 |
| 0067 | 3.2552 | 499.536 | -288451.6287 | 57576.2372 |
| 0068 | 3.3037 | 470.010 | -301970.6087 | 59128.2092 |
| 0069 | 3.3492 | 439.165 | -314816.4672 | 60584.5519 |
| 0070 | 3.3915 | 407.071 | -326933.4751 | 61941.1577 |
| 0071 | 3.4306 | 373.804 | -338268.5951 | 63194.1494 |
| 0072 | 3.4662 | 339.445 | -348771.8445 | 64339.8965 |
| 0073 | 3.4984 | 304.079 | -358396.6377 | 65375.0316 |
| 0074 | 3.5270 | 267.797 | -367100.1086 | 66296.4654 |
| 0075 | 3.5519 | 230.691 | -374843.4095 | 67101.4001 |
| 0076 | 3.5731 | 192.861 | -381591.9829 | 67787.3422 |
| 0077 | 3.5905 | 154.407 | -387315.8058 | 68352.1133 |
| 0078 | 3.6040 | 115.433 | -391989.6030 | 68793.8603 |
| 0079 | 3.6136 | 76.045 | -395593.0291 | 69111.0630 |
| 0080 | 3.6192 | 36.351 | -398110.8163 | 69302.5413 |
| 0081 | 3.6208 | -4.607 | -410768.3544 | 69374.7528 |
| 0082 | 3.6183 | -45.650 | -399798.1872 | 69299.2153 |
| 0083 | 3.6117 | -85.597 | -398961.2423 | 69103.1358 |
| 0084 | 3.6012 | -125.406 | -397030.6331 | 68780.1131 |
| 0085 | 3.5866 | -164.967 | -394017.7593 | 68330.7324 |
| 0086 | 3.5682 | -204.174 | -389939.2072 | 67755.9175 |
| 0087 | 3.5458 | -242.920 | -384816.6666 | 67056.9318 |
| 0088 | 3.5196 | -281.103 | -378676.7899 | 66235.3715 |
| 0089 | 3.4896 | -318.622 | -371551.0184 | 65293.1570 |
| 0090 | 3.4559 | -355.381 | -363475.3742 | 64232.5235 |

MAXIMUM DEFLECTION

TIME

3.6208

0.0081

INPUT DATA FOR WINBLAST PROGRAM:

BLAST PRESSURE = 50 psi
 BLAST DURATION = 26 msec
 GLASS THICKNESS = 1.06 in.
 WINDOW SIZE = 72 x 72
 ASPECT RATIO = 1
 DAMPING PERCENTAGE = 0 %

| TIME (sec) | DISPLACEMENT (in) | VELOCITY (in/sec) | ACCELERATION (in/sec2) | STRESS (psi) |
|---------------|----------------------|----------------------|---------------------------|-----------------|
| ----- | ----- | ----- | ----- | ----- |
| 0001 | 0.0001 | 1.713 | 31135.5279 | 0.6918 |
| 0002 | 0.0004 | 6.382 | 62251.1127 | 5.0563 |
| 0003 | 0.0014 | 14.161 | 93326.6906 | 17.1565 |
| 0004 | 0.0034 | 25.045 | 124342.2902 | 41.0576 |
| 0005 | 0.0066 | 39.027 | 155277.9790 | 80.8173 |
| 0006 | 0.0113 | 56.098 | 186113.8753 | 140.4832 |
| 0007 | 0.0179 | 76.246 | 216830.1619 | 224.0900 |
| 0008 | 0.0266 | 99.459 | 247407.0985 | 335.6572 |
| 0009 | 0.0379 | 125.722 | 277825.0341 | 479.1859 |
| 0010 | 0.0519 | 155.018 | 308064.4201 | 658.6572 |
| 0011 | 0.0689 | 185.709 | 305723.7636 | 877.5140 |
| 0012 | 0.0890 | 216.156 | 303186.6278 | 1136.3905 |
| 0013 | 0.1121 | 246.340 | 300454.6432 | 1434.9578 |
| 0014 | 0.1383 | 276.241 | 297529.5657 | 1772.8614 |
| 0015 | 0.1674 | 305.839 | 294413.2750 | 2149.7211 |
| 0016 | 0.1994 | 335.117 | 291107.7740 | 2565.1317 |
| 0017 | 0.2344 | 364.055 | 287615.1870 | 3018.6634 |
| 0018 | 0.2722 | 392.634 | 283937.7585 | 3509.8618 |
| 0019 | 0.3129 | 420.836 | 280077.8519 | 4038.2483 |
| 0020 | 0.3564 | 448.643 | 276037.9478 | 4603.3203 |
| 0021 | 0.4026 | 476.038 | 271820.6427 | 5204.5519 |
| 0022 | 0.4516 | 503.002 | 267428.6468 | 5841.3936 |
| 0023 | 0.5032 | 529.508 | 262542.9510 | 6528.0326 |
| 0024 | 0.5575 | 555.503 | 257316.8967 | 7265.0738 |
| 0025 | 0.6143 | 580.958 | 251625.5504 | 8038.2859 |
| 0026 | 0.6736 | 605.829 | 245751.5179 | 8848.8528 |
| 0027 | 0.7354 | 630.099 | 239612.3575 | 9693.2068 |
| 0028 | 0.7996 | 653.708 | 232711.5177 | 10568.7995 |
| 0029 | 0.8662 | 676.636 | 225816.2810 | 11476.0189 |
| 0030 | 0.9349 | 698.846 | 217984.3522 | 12411.5796 |
| 0031 | 1.0059 | 720.256 | 210155.2893 | 13369.1684 |
| 0032 | 1.0790 | 740.865 | 201985.4785 | 14355.3067 |
| 0033 | 1.1540 | 760.586 | 192359.0555 | 15357.3366 |
| 0034 | 1.2311 | 779.361 | 183069.0204 | 16375.3296 |
| 0035 | 1.3099 | 797.187 | 173395.4699 | 17417.7044 |
| 0036 | 1.3905 | 813.911 | 161614.0368 | 18510.9763 |
| 0037 | 1.4726 | 829.529 | 150672.8815 | 19638.2554 |
| 0038 | 1.5563 | 844.031 | 139315.1030 | 20786.3899 |
| 0039 | 1.6414 | 857.208 | 125027.6603 | 22013.4929 |
| 0040 | 1.7277 | 869.070 | 112150.6869 | 23280.2808 |
| 0041 | 1.8152 | 879.623 | 98837.7514 | 24563.7361 |
| 0042 | 1.9036 | 888.618 | 81701.5967 | 25926.0270 |
| 0043 | 1.9928 | 896.046 | 66778.2450 | 27337.7652 |
| 0044 | 2.0828 | 901.960 | 51430.3637 | 28760.3092 |
| 0045 | 2.1732 | 906.172 | 31333.2641 | 30340.2533 |
| 0046 | 2.2639 | 908.457 | 14316.5898 | 32191.7897 |
| 0047 | 2.3548 | 909.022 | -3077.7375 | 34046.5924 |
| 0048 | 2.4457 | 907.831 | -20811.3650 | 35901.1192 |

| | | | | |
|------|--------|----------|--------------|------------|
| 0049 | 2.5363 | 904.362 | -45018.8879 | 38064.2297 |
| 0050 | 2.6265 | 898.896 | -64349.6718 | 40284.0044 |
| 0051 | 2.7160 | 891.484 | -83909.1667 | 42488.4221 |
| 0052 | 2.8047 | 882.108 | -103640.8131 | 44672.6773 |
| 0053 | 2.8923 | 870.105 | -131557.3205 | 47097.4346 |
| 0054 | 2.9787 | 855.900 | -152547.3805 | 49515.9876 |
| 0055 | 3.0634 | 839.596 | -173526.4382 | 51892.4552 |
| 0056 | 3.1465 | 821.198 | -194419.9122 | 54220.9693 |
| 0057 | 3.2276 | 800.398 | -224486.7682 | 56602.0812 |
| 0058 | 3.3065 | 776.864 | -246151.7036 | 59119.0335 |
| 0059 | 3.3829 | 751.179 | -267477.5018 | 61558.3696 |
| 0060 | 3.4567 | 723.383 | -288373.9672 | 63913.2953 |
| 0061 | 3.5275 | 693.522 | -308750.9780 | 66177.1501 |
| 0062 | 3.5953 | 661.653 | -328519.0948 | 68343.4359 |
| 0063 | 3.6598 | 627.208 | -359388.5666 | 70556.2331 |
| 0064 | 3.7207 | 590.298 | -378664.7755 | 72771.7175 |
| 0065 | 3.7778 | 551.507 | -396997.9263 | 74850.9664 |
| 0066 | 3.8309 | 510.933 | -414296.0005 | 76787.3168 |
| 0067 | 3.8799 | 468.685 | -430471.2462 | 78574.4763 |
| 0068 | 3.9246 | 424.879 | -445440.8671 | 80206.5558 |
| 0069 | 3.9648 | 379.640 | -459127.6771 | 81678.0988 |
| 0070 | 4.0005 | 333.099 | -471460.7167 | 82984.1100 |
| 0071 | 4.0314 | 285.395 | -482375.8224 | 84120.0811 |
| 0072 | 4.0575 | 236.673 | -491816.1456 | 85082.0141 |
| 0073 | 4.0787 | 187.083 | -499732.6158 | 85866.4420 |
| 0074 | 4.0949 | 136.432 | -519985.7416 | 86484.9679 |
| 0075 | 4.1059 | 84.172 | -524927.5808 | 86959.5080 |
| 0076 | 4.1117 | 31.506 | -528104.3383 | 87218.7341 |
| 0077 | 4.1122 | -21.389 | -529499.9428 | 87261.2698 |
| 0078 | 4.1074 | -74.334 | -529109.1132 | 87086.4688 |
| 0079 | 4.0974 | -127.151 | -526937.4222 | 86694.4181 |
| 0080 | 4.0820 | -179.043 | -509297.6344 | 86119.2467 |
| 0081 | 4.0616 | -229.723 | -504043.1376 | 85398.2651 |
| 0082 | 4.0361 | -279.799 | -497223.5080 | 84494.8255 |
| 0083 | 4.0057 | -329.116 | -488879.6384 | 83411.3370 |
| 0084 | 3.9703 | -377.525 | -479060.7481 | 82150.7614 |
| 0085 | 3.9302 | -424.881 | -467824.0063 | 80716.5955 |
| 0086 | 3.8854 | -471.045 | -455234.0945 | 79112.8510 |
| 0087 | 3.8360 | -515.885 | -441362.7114 | 77344.0311 |
| 0088 | 3.7823 | -559.277 | -426288.0247 | 75415.1050 |
| 0089 | 3.7242 | -601.105 | -410094.0763 | 73331.4799 |
| 0090 | 3.6621 | -641.261 | -392870.1442 | 71098.9705 |

MAXIMUM DEFLECTION

TIME

4.1127

0.0077

INPUT DATA FOR WINBLAST PROGRAM:

BLAST PRESSURE = 14.6 psi
 BLAST DURATION = 26 msec
 GLASS THICKNESS = .71 in.
 WINDOW SIZE = 27 x 20
 ASPECT RATIO = 1.35
 DAMPING PERCENTAGE = 0 %

| TIME (sec) | DISPLACEMENT (in) | VELOCITY (in/sec) | ACCELERATION (in/sec ²) | STRESS (psi) |
|---------------|----------------------|----------------------|--|-----------------|
| ----- | ----- | ----- | ----- | ----- |
| 0001 | 0.0000 | 0.742 | 13456.2827 | 2.3673 |
| 0002 | 0.0002 | 2.746 | 26526.4818 | 17.2335 |
| 0003 | 0.0006 | 6.022 | 38833.0233 | 58.0800 |
| 0004 | 0.0014 | 10.475 | 50021.6203 | 137.6659 |
| 0005 | 0.0028 | 15.978 | 59770.1699 | 267.6348 |
| 0006 | 0.0047 | 22.371 | 67798.0260 | 458.1803 |
| 0007 | 0.0072 | 29.472 | 73874.0786 | 717.7517 |
| 0008 | 0.0106 | 37.075 | 77823.4073 | 1052.8112 |
| 0009 | 0.0147 | 44.961 | 79532.3169 | 1467.6481 |
| 0010 | 0.0196 | 52.905 | 78951.6104 | 1964.2546 |
| 0011 | 0.0252 | 59.973 | 62081.9140 | 2540.5063 |
| 0012 | 0.0315 | 65.261 | 43424.9724 | 3182.4661 |
| 0013 | 0.0382 | 68.616 | 23517.8911 | 3871.0980 |
| 0014 | 0.0452 | 69.942 | 2933.7649 | 4586.0199 |
| 0015 | 0.0521 | 69.200 | -17734.8200 | 5306.0928 |
| 0016 | 0.0589 | 66.412 | -37892.8459 | 6010.0296 |
| 0017 | 0.0653 | 61.658 | -56959.9938 | 6677.0075 |
| 0018 | 0.0712 | 55.075 | -74387.3488 | 7287.2680 |
| 0019 | 0.0763 | 46.852 | -89673.2036 | 7822.6850 |
| 0020 | 0.0805 | 37.227 | -102377.5015 | 8267.2874 |
| 0021 | 0.0837 | 26.476 | -112134.5047 | 8607.7183 |
| 0022 | 0.0858 | 14.908 | -118663.3237 | 8833.6198 |
| 0023 | 0.0867 | 2.858 | -121776.0036 | 8937.9311 |
| 0024 | 0.0864 | -9.329 | -121382.9351 | 8917.0920 |
| 0025 | 0.0848 | -21.302 | -117495.4340 | 8771.1448 |
| 0026 | 0.0821 | -32.715 | -110225.4156 | 8503.7339 |
| 0027 | 0.0783 | -43.240 | -99782.1728 | 8122.0002 |
| 0028 | 0.0735 | -52.575 | -86466.3510 | 7636.3758 |
| 0029 | 0.0678 | -60.450 | -70661.2926 | 7060.2837 |
| 0030 | 0.0615 | -66.639 | -52822.0017 | 6409.7514 |
| 0031 | 0.0546 | -70.964 | -33462.0445 | 5702.9492 |
| 0032 | 0.0473 | -73.299 | -13138.7653 | 4959.6677 |
| 0033 | 0.0400 | -73.579 | 7562.7592 | 4200.7473 |
| 0034 | 0.0327 | -71.794 | 28046.5633 | 3447.4788 |
| 0035 | 0.0257 | -67.996 | 47722.9489 | 2720.9903 |
| 0036 | 0.0192 | -62.295 | 66025.4623 | 2041.6389 |
| 0037 | 0.0133 | -54.855 | 82427.2018 | 1428.4248 |
| 0038 | 0.0082 | -45.890 | 96455.9858 | 898.4439 |
| 0039 | 0.0042 | -35.657 | 107707.9466 | 466.3964 |
| 0040 | 0.0011 | -24.452 | 115859.1573 | 144.1628 |
| 0041 | -0.0007 | -12.597 | 120674.9566 | -59.5378 |
| 0042 | -0.0014 | -0.433 | 122016.7049 | -139.3983 |

| MAXIMUM DEFLECTION | TIME |
|--------------------|--------|
| ----- | ---- |
| 0.0867 | 0.0023 |

INPUT DATA FOR WINBLAST PROGRAM:

BLAST PRESSURE = 14.6 psi
 BLAST DURATION = 26 msec
 GLASS THICKNESS = .71 in.
 WINDOW SIZE = 32 x 20
 ASPECT RATIO = 1.6
 DAMPING PERCENTAGE = 0 %

| TIME (sec) | DISPLACEMENT (in) | VELOCITY (in/sec) | ACCELERATION (in/sec ²) | STRESS (psi) |
|---------------|----------------------|----------------------|--|-----------------|
| ----- | ----- | ----- | ----- | ----- |
| 00001 | 0.0000 | 0.740 | 13424.3142 | 2.2754 |
| 00002 | 0.0002 | 2.742 | 26541.4636 | 16.5782 |
| 00003 | 0.0006 | 6.028 | 39049.2663 | 55.9499 |
| 00004 | 0.0014 | 10.522 | 50660.5645 | 132.8813 |
| 00005 | 0.0028 | 16.121 | 61108.7828 | 259.0007 |
| 00006 | 0.0047 | 22.697 | 70154.0477 | 444.8069 |
| 00007 | 0.0073 | 30.098 | 77588.6955 | 699.4289 |
| 00008 | 0.0107 | 38.155 | 83242.0394 | 1030.4154 |
| 00009 | 0.0150 | 46.682 | 86984.2882 | 1443.5621 |
| 00010 | 0.0201 | 55.484 | 88729.5263 | 1942.7783 |
| 00011 | 0.0261 | 63.659 | 74459.2598 | 2528.3033 |
| 00012 | 0.0328 | 70.319 | 58479.5359 | 3189.2434 |
| 00013 | 0.0401 | 75.310 | 41157.2217 | 3909.8913 |
| 00014 | 0.0478 | 78.519 | 22890.0080 | 4673.1662 |
| 00015 | 0.0557 | 79.871 | 4097.2788 | 5461.0089 |
| 00016 | 0.0637 | 79.335 | -14789.5169 | 6254.7961 |
| 00017 | 0.0715 | 76.924 | -33336.7706 | 7035.7680 |
| 00018 | 0.0790 | 72.693 | -51118.6689 | 7785.4591 |
| 00019 | 0.0860 | 66.740 | -67726.9699 | 8486.1219 |
| 00020 | 0.0923 | 59.200 | -82780.3754 | 9121.1346 |
| 00021 | 0.0978 | 50.247 | -95933.2848 | 9675.3827 |
| 00022 | 0.1023 | 40.087 | -106883.7299 | 10135.6057 |
| 00023 | 0.1058 | 28.953 | -115380.3070 | 10490.7021 |
| 00024 | 0.1081 | 17.100 | -121227.9494 | 10731.9835 |
| 00025 | 0.1092 | 4.801 | -124292.4051 | 10853.3748 |
| 00026 | 0.1090 | -7.663 | -124503.3194 | 10851.5532 |
| 00027 | 0.1076 | -20.004 | -121855.8502 | 10726.0249 |
| 00028 | 0.1050 | -31.940 | -116410.7788 | 10479.1359 |
| 00029 | 0.1013 | -43.197 | -108293.1147 | 10116.0186 |
| 00030 | 0.0964 | -53.515 | -97689.2256 | 9644.4738 |
| 00031 | 0.0906 | -62.659 | -84842.5588 | 9074.7916 |
| 00032 | 0.0839 | -70.419 | -70048.0517 | 8419.5151 |
| 00033 | 0.0766 | -76.615 | -53645.3610 | 7693.1525 |
| 00034 | 0.0687 | -81.106 | -36011.0645 | 6911.8442 |
| 00035 | 0.0604 | -83.790 | -17550.0153 | 6092.9918 |
| 00036 | 0.0520 | -84.603 | 1313.9521 | 5254.8590 |
| 00037 | 0.0436 | -83.528 | 20147.7535 | 4416.1522 |
| 00038 | 0.0353 | -80.589 | 38518.9969 | 3595.5908 |
| 00039 | 0.0275 | -75.854 | 56005.9099 | 2811.4778 |
| 00040 | 0.0202 | -69.431 | 72207.0229 | 2081.2792 |
| 00041 | 0.0137 | -61.468 | 86750.3859 | 1421.2234 |
| 00042 | 0.0080 | -52.148 | 99302.1082 | 845.9284 |

| MAXIMUM DEFLECTION | TIME |
|--------------------|--------|
| ----- | ---- |
| 0.1093 | 0.0025 |

INPUT DATA FOR WINBLAST PROGRAM:

BLAST PRESSURE = 14.6 psi
 BLAST DURATION = 26 msec
 GLASS THICKNESS = .71 in.
 WINDOW SIZE = 72 x 24
 ASPECT RATIO = 3
 DAMPING PERCENTAGE = 0 %

| TIME (sec) | DISPLACEMENT (in) | VELOCITY (in/sec) | ACCELERATION (in/sec2) | STRESS (psi) |
|---------------|----------------------|----------------------|---------------------------|-----------------|
| ----- | ----- | ----- | ----- | ----- |
| 0001 | 0.0000 | 0.709 | 12881.7874 | 1.4251 |
| 0002 | 0.0002 | 2.638 | 25672.5983 | 10.4072 |
| 0003 | 0.0006 | 5.837 | 38281.4910 | 35.2580 |
| 0004 | 0.0014 | 10.285 | 50619.1178 | 84.1921 |
| 0005 | 0.0027 | 15.949 | 62598.0533 | 165.2535 |
| 0006 | 0.0046 | 22.790 | 74133.4137 | 286.2585 |
| 0007 | 0.0073 | 30.758 | 85143.4585 | 454.7405 |
| 0008 | 0.0108 | 39.798 | 95550.1695 | 677.8964 |
| 0009 | 0.0153 | 49.846 | 105279.8041 | 962.5355 |
| 0010 | 0.0208 | 60.829 | 114263.4170 | 1315.0316 |
| 0011 | 0.0275 | 72.001 | 109035.2238 | 1740.2171 |
| 0012 | 0.0352 | 82.610 | 103034.3978 | 2236.6752 |
| 0013 | 0.0440 | 92.583 | 96303.4613 | 2800.5538 |
| 0014 | 0.0537 | 101.848 | 88890.1104 | 3427.5216 |
| 0015 | 0.0643 | 110.340 | 80846.8767 | 4112.8002 |
| 0016 | 0.0757 | 117.998 | 72230.7553 | 4851.1980 |
| 0017 | 0.0879 | 124.769 | 63102.8006 | 5637.1470 |
| 0018 | 0.1006 | 130.604 | 53527.6941 | 6464.7424 |
| 0019 | 0.1140 | 135.462 | 43573.6615 | 7327.6368 |
| 0020 | 0.1277 | 139.308 | 33310.0870 | 8218.9054 |
| 0021 | 0.1418 | 142.116 | 22806.3651 | 9132.4931 |
| 0022 | 0.1561 | 143.864 | 12127.5101 | 10061.6603 |
| 0023 | 0.1705 | 144.538 | 1359.2378 | 10999.4109 |
| 0024 | 0.1850 | 144.135 | -9394.6631 | 11938.7041 |
| 0025 | 0.1993 | 142.659 | -20119.3283 | 12872.3618 |
| 0026 | 0.2135 | 140.116 | -30703.8957 | 13793.6421 |
| 0027 | 0.2273 | 136.525 | -41072.9285 | 14695.6573 |
| 0028 | 0.2407 | 131.914 | -51084.9573 | 15571.2605 |
| 0029 | 0.2537 | 126.316 | -60814.0652 | 16413.9363 |
| 0030 | 0.2660 | 119.766 | -70115.3885 | 17217.7593 |
| 0031 | 0.2776 | 112.310 | -78921.7520 | 17976.6626 |
| 0032 | 0.2884 | 104.000 | -87169.4064 | 18684.8963 |
| 0033 | 0.2983 | 94.897 | -94798.5175 | 19337.0692 |
| 0034 | 0.3074 | 85.075 | -101617.5765 | 19927.6988 |
| 0035 | 0.3153 | 74.595 | -107850.9140 | 20452.7905 |
| 0036 | 0.3223 | 63.530 | -113315.1018 | 20908.3319 |
| 0037 | 0.3280 | 51.959 | -117970.1402 | 21290.7291 |
| 0038 | 0.3326 | 39.965 | -121781.9151 | 21596.9100 |
| 0039 | 0.3360 | 27.632 | -124722.4728 | 21824.3475 |
| 0040 | 0.3381 | 15.050 | -126770.2463 | 21971.0779 |
| 0041 | 0.3390 | 2.309 | -127910.2296 | 22035.7148 |
| 0042 | 0.3386 | -10.501 | -128134.0998 | 22017.4600 |
| 0043 | 0.3369 | -23.287 | -127440.2843 | 21916.1087 |
| 0044 | 0.3340 | -35.959 | -125833.9732 | 21732.0514 |
| 0045 | 0.3297 | -48.424 | -123327.0758 | 21466.2708 |
| 0046 | 0.3243 | -60.595 | -119938.1233 | 21120.3344 |
| 0047 | 0.3176 | -72.383 | -115692.1164 | 20696.3831 |
| 0048 | 0.3098 | -83.705 | -110620.3224 | 20197.1153 |

| | | | | |
|--------|---------|----------|--------------|------------|
| 0.0049 | 0.3009 | -94.481 | -104760.0206 | 19625.7670 |
| 0.0050 | 0.2909 | -104.641 | -98291.6044 | 18985.6496 |
| 0.0051 | 0.2800 | -114.111 | -90988.4532 | 18281.0810 |
| 0.0052 | 0.2681 | -122.817 | -83040.0995 | 17516.9615 |
| 0.0053 | 0.2555 | -130.699 | -74504.3404 | 16698.4097 |
| 0.0054 | 0.2420 | -137.701 | -65443.0969 | 15830.9294 |
| 0.0055 | 0.2280 | -143.774 | -55994.9121 | 14920.1699 |
| 0.0056 | 0.2133 | -148.881 | -46089.2192 | 13971.7834 |
| 0.0057 | 0.1982 | -152.981 | -35859.0128 | 12992.8006 |
| 0.0058 | 0.1828 | -156.045 | -25377.3281 | 11989.8487 |
| 0.0059 | 0.1670 | -158.053 | -14752.1764 | 10969.4863 |
| 0.0060 | 0.1512 | -158.991 | -3999.3963 | 9938.7860 |
| 0.0061 | 0.1353 | -158.852 | 6776.1273 | 8904.8103 |
| 0.0062 | 0.1194 | -157.638 | 17492.9039 | 7874.6005 |
| 0.0063 | 0.1038 | -155.358 | 28080.8754 | 6854.8036 |
| 0.0064 | 0.0884 | -152.029 | 38468.2779 | 5851.9669 |
| 0.0065 | 0.0734 | -147.674 | 48583.0909 | 4873.4796 |
| 0.0066 | 0.0589 | -142.324 | 58353.6401 | 3925.9398 |
| 0.0067 | 0.0450 | -136.017 | 67710.6905 | 3015.7262 |
| 0.0068 | 0.0317 | -128.797 | 76587.9372 | 2148.9530 |
| 0.0069 | 0.0192 | -120.717 | 84922.4753 | 1331.4267 |
| 0.0070 | 0.0076 | -111.833 | 92655.2456 | 568.6047 |
| 0.0071 | -0.0031 | -102.208 | 99731.4531 | -134.4434 |
| 0.0072 | -0.0128 | -91.911 | 106100.9551 | -773.0711 |
| 0.0073 | -0.0215 | -81.013 | 111718.6167 | -1343.0888 |
| 0.0074 | -0.0290 | -69.593 | 116544.6309 | -1840.7929 |
| 0.0075 | -0.0354 | -57.732 | 120544.8000 | -2262.9923 |

MAXIMUM DEFLECTION

TIME

0.3390

0.0041

INPUT DATA FOR WINBLAST PROGRAM:

BLAST PRESSURE = 75 psi
 BLAST DURATION = 26 msec
 GLASS THICKNESS = .71 in.
 WINDOW SIZE = 72 x 24
 ASPECT RATIO = 3
 DAMPING PERCENTAGE = 0 %

| TIME (sec) | DISPLACEMENT (in) | VELOCITY (in/sec) | ACCELERATION (in/sec2) | STRESS (psi) |
|---------------|----------------------|----------------------|---------------------------|-----------------|
| ----- | ----- | ----- | ----- | ----- |
| 0.0001 | 0.0001 | 3.642 | 66173.5653 | 7.3209 |
| 0.0002 | 0.0010 | 13.550 | 131879.7856 | 53.4618 |
| 0.0003 | 0.0031 | 29.987 | 196651.4946 | 181.1198 |
| 0.0004 | 0.0072 | 52.834 | 260029.7146 | 432.4935 |
| 0.0005 | 0.0138 | 81.931 | 321565.3421 | 848.9049 |
| 0.0006 | 0.0237 | 117.071 | 380822.3305 | 1470.5062 |
| 0.0007 | 0.0375 | 158.005 | 437380.7798 | 2335.9960 |
| 0.0008 | 0.0555 | 204.443 | 490839.9120 | 3482.3444 |
| 0.0009 | 0.0785 | 256.056 | 540820.9113 | 4944.5315 |
| 0.0010 | 0.1069 | 312.479 | 586969.6081 | 6755.2992 |
| 0.0011 | 0.1410 | 369.872 | 560261.6281 | 8937.9430 |
| 0.0012 | 0.1808 | 424.389 | 529402.0075 | 11486.3170 |
| 0.0013 | 0.2258 | 475.623 | 494650.1878 | 14380.1292 |
| 0.0014 | 0.2758 | 523.213 | 456581.9831 | 17595.3415 |
| 0.0015 | 0.3303 | 566.833 | 415306.0982 | 21107.0918 |
| 0.0016 | 0.3890 | 606.163 | 370799.1371 | 24889.0764 |
| 0.0017 | 0.4514 | 640.912 | 323580.3166 | 28916.1481 |
| 0.0018 | 0.5170 | 670.803 | 274037.5924 | 33156.6137 |
| 0.0019 | 0.5854 | 695.614 | 221831.1214 | 37578.9164 |
| 0.0020 | 0.6560 | 715.120 | 168267.5737 | 42149.1377 |
| 0.0021 | 0.7282 | 729.166 | 112414.6662 | 46833.3082 |
| 0.0022 | 0.8016 | 737.562 | 55352.4430 | 51594.0932 |
| 0.0023 | 0.8756 | 740.260 | -2065.4782 | 56394.1627 |
| 0.0024 | 0.9495 | 737.123 | -60723.1780 | 61196.5892 |
| 0.0025 | 1.0228 | 728.116 | -119380.0444 | 65963.3910 |
| 0.0026 | 1.0949 | 713.329 | -177169.9030 | 70652.4891 |
| 0.0027 | 1.1653 | 692.706 | -235096.3004 | 75230.1530 |
| 0.0028 | 1.2333 | 666.355 | -291647.2593 | 79659.0770 |
| 0.0029 | 1.2983 | 634.439 | -346335.5564 | 83902.3111 |
| 0.0030 | 1.3600 | 597.127 | -399477.3422 | 87912.3134 |
| 0.0031 | 1.4176 | 554.639 | -449766.3962 | 91667.4274 |
| 0.0032 | 1.4707 | 507.286 | -496701.4516 | 95134.9520 |
| 0.0033 | 1.5189 | 455.428 | -539803.0389 | 98284.3225 |
| 0.0034 | 1.5617 | 399.469 | -578621.2187 | 101087.4220 |
| 0.0035 | 1.5987 | 339.861 | -612743.1596 | 103518.8743 |
| 0.0036 | 1.6295 | 277.062 | -643008.3111 | 105553.1750 |
| 0.0037 | 1.6540 | 211.509 | -667122.2075 | 107166.7904 |
| 0.0038 | 1.6718 | 143.831 | -685466.5092 | 108353.2766 |
| 0.0039 | 1.6827 | 74.616 | -697830.1618 | 109100.4760 |
| 0.0040 | 1.6867 | 4.470 | -704072.2419 | 109400.0600 |
| 0.0041 | 1.6836 | -65.991 | -704124.8419 | 109247.6240 |
| 0.0042 | 1.6735 | -136.148 | -697994.4728 | 108642.7358 |
| 0.0043 | 1.6564 | -205.386 | -685761.9378 | 107588.9361 |
| 0.0044 | 1.6325 | -273.101 | -667580.6782 | 106093.6915 |
| 0.0045 | 1.6018 | -338.667 | -642844.4271 | 104162.7514 |
| 0.0046 | 1.5648 | -401.558 | -614118.0313 | 101807.9150 |
| 0.0047 | 1.5216 | -461.323 | -580376.7408 | 99054.1055 |
| 0.0048 | 1.4727 | -517.478 | -541995.5932 | 95922.8143 |

| | | | | |
|--------|---------|----------|--------------|-------------|
| 0.0049 | 1.4183 | -569.580 | -499392.8002 | 92438.5570 |
| 0.0050 | 1.3589 | -617.230 | -453022.4091 | 88628.6065 |
| 0.0051 | 1.2950 | -660.075 | -403366.6177 | 84522.7011 |
| 0.0052 | 1.2271 | -697.840 | -351623.8067 | 80141.4232 |
| 0.0053 | 1.1556 | -730.323 | -297690.8106 | 75526.6326 |
| 0.0054 | 1.0812 | -757.317 | -241926.8016 | 70715.2379 |
| 0.0055 | 1.0043 | -778.678 | -185853.3530 | 65742.7612 |
| 0.0056 | 0.9256 | -794.399 | -128454.2257 | 60641.9047 |
| 0.0057 | 0.8456 | -804.354 | -70600.9731 | 55453.9053 |
| 0.0058 | 0.7649 | -808.548 | -13610.3369 | 50216.0683 |
| 0.0059 | 0.6841 | -807.047 | 43536.0022 | 44965.3933 |
| 0.0060 | 0.6037 | -799.881 | 99293.6834 | 39739.6942 |
| 0.0061 | 0.5243 | -787.188 | 154358.8927 | 34576.6009 |
| 0.0062 | 0.4465 | -769.077 | 207536.5033 | 29510.7533 |
| 0.0063 | 0.3707 | -745.721 | 259092.2344 | 24577.0140 |
| 0.0064 | 0.2975 | -717.315 | 308657.4171 | 19809.9227 |
| 0.0065 | 0.2274 | -684.084 | 355681.8940 | 15235.6184 |
| 0.0066 | 0.1608 | -646.260 | 400364.8195 | 10884.6446 |
| 0.0067 | 0.0983 | -604.115 | 441975.7702 | 6789.8392 |
| 0.0068 | 0.0401 | -557.962 | 480544.9553 | 2976.8011 |
| 0.0069 | -0.0132 | -508.120 | 515708.9584 | -526.1262 |
| 0.0070 | -0.0614 | -454.943 | 547218.6043 | -3695.8449 |
| 0.0071 | -0.1041 | -398.807 | 574850.6131 | -6511.6182 |
| 0.0072 | -0.1410 | -340.102 | 598591.9631 | -8953.6610 |
| 0.0073 | -0.1720 | -279.238 | 617972.5797 | -11007.7757 |
| 0.0074 | -0.1968 | -216.657 | 632898.7827 | -12661.2139 |
| 0.0075 | -0.2153 | -152.807 | 643352.0871 | -13904.0995 |

MAXIMUM DEFLECTION

TIME

1.6867

0.0040

INPUT DATA FOR WINBLAST PROGRAM:

BLAST PRESSURE = 14.6 psi
 BLAST DURATION = 26 msec
 GLASS THICKNESS = .71 in.
 WINDOW SIZE = 26 x 26
 ASPECT RATIO = 1
 DAMPING PERCENTAGE = 4 %

| TIME (sec) | DISPLACEMENT (in) | VELOCITY (in/sec) | ACCELERATION (in/sec2) | STRESS (psi) |
|---------------|----------------------|----------------------|---------------------------|-----------------|
| ----- | ----- | ----- | ----- | ----- |
| 0001 | 0.0000 | 0.742 | 13447.5606 | 1.5424 |
| 0002 | 0.0002 | 2.745 | 26536.9893 | 11.2219 |
| 0003 | 0.0006 | 6.030 | 39043.7523 | 37.8354 |
| 0004 | 0.0014 | 10.527 | 50763.2108 | 89.8200 |
| 0005 | 0.0028 | 16.150 | 61506.1088 | 175.0979 |
| 0006 | 0.0047 | 22.790 | 71101.6017 | 300.9484 |
| 0007 | 0.0074 | 30.327 | 79399.9438 | 473.8920 |
| 0008 | 0.0108 | 38.622 | 86274.7914 | 699.5880 |
| 0009 | 0.0151 | 47.530 | 91625.0894 | 982.7490 |
| 0010 | 0.0203 | 56.894 | 95376.5108 | 1327.0702 |
| 0011 | 0.0265 | 65.848 | 83477.1071 | 1734.0296 |
| 0012 | 0.0334 | 73.546 | 70294.8422 | 2197.8421 |
| 0013 | 0.0411 | 79.872 | 56065.0668 | 2709.7446 |
| 0014 | 0.0494 | 84.733 | 41038.3380 | 3260.2533 |
| 0015 | 0.0580 | 88.062 | 25476.0407 | 3839.3324 |
| 0016 | 0.0669 | 89.819 | 9645.8732 | 4436.5686 |
| 0017 | 0.0759 | 89.991 | -6182.7284 | 5041.3510 |
| 0018 | 0.0849 | 88.591 | -21743.1465 | 5643.0513 |
| 0019 | 0.0936 | 85.660 | -36776.0443 | 6231.2033 |
| 0020 | 0.1020 | 81.262 | -51033.6584 | 6795.6775 |
| 0021 | 0.1098 | 75.487 | -64283.8528 | 7326.8483 |
| 0022 | 0.1170 | 68.446 | -76313.8673 | 7815.7508 |
| 0023 | 0.1235 | 60.271 | -86933.7004 | 8254.2249 |
| 0024 | 0.1290 | 51.112 | -95979.0745 | 8635.0448 |
| 0025 | 0.1337 | 41.133 | -103313.9361 | 8952.0305 |
| 0026 | 0.1372 | 30.510 | -108832.4554 | 9200.1415 |
| 0027 | 0.1397 | 19.430 | -112460.4957 | 9375.5496 |
| 0028 | 0.1411 | 8.083 | -114156.5338 | 9475.6911 |
| 0029 | 0.1414 | -3.336 | -113912.0216 | 9499.2968 |
| 0030 | 0.1405 | -14.635 | -111751.1883 | 9446.3995 |
| 0031 | 0.1384 | -25.624 | -107730.2924 | 9318.3209 |
| 0032 | 0.1353 | -36.122 | -101936.3424 | 9117.6351 |
| 0033 | 0.1312 | -45.956 | -94485.3122 | 8848.1127 |
| 0034 | 0.1262 | -54.968 | -85519.8876 | 8514.6446 |
| 0035 | 0.1203 | -63.015 | -75206.7857 | 8123.1485 |
| 0036 | 0.1136 | -69.971 | -63733.6975 | 7680.4581 |
| 0037 | 0.1063 | -75.730 | -51305.9092 | 7194.1986 |
| 0038 | 0.0985 | -80.207 | -38142.6613 | 6672.6501 |
| 0039 | 0.0903 | -83.341 | -24473.3113 | 6124.6015 |
| 0040 | 0.0819 | -85.093 | -10533.3651 | 5559.1968 |

| MAXIMUM DEFLECTION | TIME |
|--------------------|--------|
| ----- | ---- |
| 0.1414 | 0.0029 |

INPUT DATA FOR WINBLAST PROGRAM:

BLAST PRESSURE = 7.3 psi
 BLAST DURATION = 26 msec
 GLASS THICKNESS = .355 in.
 WINDOW SIZE = 26 x 26
 ASPECT RATIO = 1
 DAMPING PERCENTAGE = 4 %

| TIME (sec) | DISPLACEMENT (in) | VELOCITY (in/sec) | ACCELERATION (in/sec2) | STRESS (psi) |
|---------------|----------------------|----------------------|---------------------------|-----------------|
| ----- | ----- | ----- | ----- | ----- |
| .0001 | 0.0000 | 0.745 | 13523.8311 | 0.7731 |
| .0002 | 0.0002 | 2.768 | 26923.9483 | 5.6416 |
| .0003 | 0.0006 | 6.123 | 40140.6481 | 19.1023 |
| .0004 | 0.0015 | 10.788 | 53119.0198 | 45.6008 |
| .0005 | 0.0028 | 16.737 | 65805.4451 | 89.5046 |
| .0006 | 0.0049 | 23.938 | 78147.8183 | 155.0845 |
| .0007 | 0.0077 | 32.354 | 90095.7587 | 246.4980 |
| .0008 | 0.0114 | 41.942 | 101600.8144 | 367.7715 |
| .0009 | 0.0161 | 52.657 | 112616.6572 | 522.7844 |
| .0010 | 0.0219 | 64.448 | 123099.2674 | 715.2532 |
| .0011 | 0.0290 | 76.554 | 118935.4944 | 948.1415 |
| .0012 | 0.0372 | 88.219 | 114290.6420 | 1221.1185 |
| .0013 | 0.0466 | 99.396 | 109186.8419 | 1532.6412 |
| .0014 | 0.0571 | 110.042 | 103648.0511 | 1881.0107 |
| .0015 | 0.0686 | 120.112 | 97699.9404 | 2264.3810 |
| .0016 | 0.0811 | 129.569 | 91369.7777 | 2680.7683 |
| .0017 | 0.0945 | 138.374 | 84686.3039 | 3128.0589 |
| .0018 | 0.1087 | 146.495 | 77679.6037 | 3604.0200 |
| .0019 | 0.1238 | 153.901 | 70380.9722 | 4106.3090 |
| .0020 | 0.1395 | 160.563 | 62822.7753 | 4632.4840 |
| .0021 | 0.1559 | 166.458 | 55038.3084 | 5180.0152 |
| .0022 | 0.1728 | 171.527 | 46329.6694 | 5765.2353 |
| .0023 | 0.1901 | 175.719 | 37454.6450 | 6372.6899 |
| .0024 | 0.2079 | 178.989 | 27825.1750 | 6994.8027 |
| .0025 | 0.2259 | 181.297 | 18287.8696 | 7628.8449 |
| .0026 | 0.2441 | 182.641 | 8577.5761 | 8269.6631 |
| .0027 | 0.2624 | 182.943 | -2242.5573 | 8912.7313 |
| .0028 | 0.2807 | 182.207 | -12481.9169 | 9554.9610 |
| .0029 | 0.2988 | 180.445 | -22759.2729 | 10193.1631 |
| .0030 | 0.3167 | 177.580 | -34516.7863 | 10819.8039 |
| .0031 | 0.3343 | 173.598 | -45103.9517 | 11431.8667 |
| .0032 | 0.3514 | 168.564 | -55536.7822 | 12028.6206 |
| .0033 | 0.3680 | 162.498 | -65737.4962 | 12606.4346 |
| .0034 | 0.3839 | 155.262 | -77996.8149 | 13152.8756 |
| .0035 | 0.3990 | 146.961 | -87940.5744 | 13670.2785 |
| .0036 | 0.4132 | 137.691 | -97387.6463 | 14158.0960 |
| .0037 | 0.4265 | 127.503 | -106251.7116 | 14613.0968 |
| .0038 | 0.4387 | 116.463 | -114450.0798 | 15032.2455 |
| .0039 | 0.4497 | 104.495 | -125170.6793 | 15418.6263 |
| .0040 | 0.4596 | 91.623 | -132120.4975 | 15769.4734 |
| .0041 | 0.4680 | 78.103 | -138123.9190 | 16073.9454 |
| .0042 | 0.4752 | 64.032 | -143118.3036 | 16329.8909 |
| .0043 | 0.4808 | 49.514 | -147052.0780 | 16535.5119 |
| .0044 | 0.4850 | 34.658 | -149885.6861 | 16689.3832 |
| .0045 | 0.4878 | 19.575 | -151592.3145 | 16790.4659 |
| .0046 | 0.4890 | 4.378 | -152158.3756 | 16838.1183 |
| .0047 | 0.4886 | -10.818 | -151583.7363 | 16832.1000 |
| .0048 | 0.4868 | -25.901 | -149881.6887 | 16772.5736 |

| | | | | |
|-------|--------|----------|--------------|------------|
| .0049 | 0.4835 | -40.758 | -147078.6637 | 16660.0995 |
| .0050 | 0.4787 | -55.281 | -143213.6975 | 16495.6277 |
| .0051 | 0.4724 | -69.367 | -138337.6642 | 16280.4841 |
| .0052 | 0.4648 | -82.917 | -132512.2974 | 16016.3533 |
| .0053 | 0.4559 | -95.840 | -125809.0237 | 15705.2569 |
| .0054 | 0.4457 | -108.052 | -118307.6414 | 15349.5287 |

MAXIMUM DEFLECTION

TIME

0.4890

0.0046

INPUT DATA FOR WINBLAST PROGRAM:

BLAST PRESSURE = 14.6 psi
 BLAST DURATION = 26 msec
 GLASS THICKNESS = .801 in.
 WINDOW SIZE = 26 x 26
 ASPECT RATIO = 1
 DAMPING PERCENTAGE = 4 %

| TIME (sec) | DISPLACEMENT (in) | VELOCITY (in/sec) | ACCELERATION (in/sec2) | STRESS (psi) |
|---------------|----------------------|----------------------|---------------------------|-----------------|
| ----- | ----- | ----- | ----- | ----- |
| 0001 | 0.0000 | 0.657 | 11898.9759 | 1.5412 |
| 0002 | 0.0002 | 2.427 | 23411.9259 | 11.2029 |
| 0003 | 0.0005 | 5.318 | 34288.9459 | 37.7180 |
| 0004 | 0.0013 | 9.256 | 44304.5106 | 89.3729 |
| 0005 | 0.0024 | 14.143 | 53254.1798 | 173.8190 |
| 0006 | 0.0041 | 19.865 | 60958.7301 | 297.9158 |
| 0007 | 0.0064 | 26.288 | 67267.6992 | 467.5934 |
| 0008 | 0.0094 | 33.267 | 72062.2719 | 687.7367 |
| 0009 | 0.0131 | 40.647 | 75257.4556 | 962.0923 |
| 0010 | 0.0175 | 48.264 | 76803.5051 | 1293.2023 |
| 0011 | 0.0227 | 55.330 | 64290.2081 | 1681.2150 |
| 0012 | 0.0286 | 61.080 | 50546.1955 | 2118.8724 |
| 0013 | 0.0349 | 65.408 | 35880.2045 | 2595.8606 |
| 0014 | 0.0416 | 68.237 | 20617.1115 | 3101.1422 |
| 0015 | 0.0485 | 69.523 | 5090.7852 | 3623.2031 |
| 0016 | 0.0554 | 69.257 | -10363.1685 | 4150.3039 |
| 0017 | 0.0623 | 67.464 | -25414.6150 | 4670.7347 |
| 0018 | 0.0689 | 64.198 | -39745.8974 | 5173.0653 |
| 0019 | 0.0751 | 59.549 | -53058.4938 | 5646.3865 |
| 0020 | 0.0808 | 53.630 | -65079.1879 | 6080.5381 |
| 0021 | 0.0858 | 46.584 | -75565.6241 | 6466.3172 |
| 0022 | 0.0900 | 38.575 | -84311.1381 | 6795.6648 |
| 0023 | 0.0935 | 29.786 | -91148.7657 | 7061.8244 |
| 0024 | 0.0960 | 20.414 | -95954.3551 | 7259.4718 |
| 0025 | 0.0975 | 10.666 | -98648.7255 | 7384.8124 |
| 0026 | 0.0981 | 0.756 | -99198.8376 | 7435.6445 |
| 0027 | 0.0977 | -9.103 | -97617.9622 | 7411.3878 |
| 0028 | 0.0963 | -18.698 | -93964.8547 | 7313.0772 |
| 0029 | 0.0940 | -27.830 | -88341.9654 | 7143.3213 |
| 0030 | 0.0908 | -36.306 | -80892.7350 | 6906.2285 |
| 0031 | 0.0867 | -43.953 | -71798.0431 | 6607.3014 |
| 0032 | 0.0820 | -50.617 | -61271.8974 | 6253.3025 |
| 0033 | 0.0766 | -56.167 | -49556.4627 | 5852.0949 |
| 0034 | 0.0708 | -60.498 | -36916.5460 | 5412.4609 |
| 0035 | 0.0646 | -63.529 | -23633.6599 | 4943.9030 |
| 0036 | 0.0581 | -65.213 | -9999.7988 | 4456.4323 |
| 0037 | 0.0516 | -65.527 | 3688.9379 | 3960.3481 |
| 0038 | 0.0451 | -64.483 | 17138.7346 | 3466.0136 |
| 0039 | 0.0387 | -62.117 | 30064.3262 | 2983.6336 |
| 0040 | 0.0327 | -58.497 | 42195.0074 | 2523.0376 |
| 0041 | 0.0271 | -53.713 | 53280.2606 | 2093.4736 |
| 0042 | 0.0220 | -47.883 | 63094.8851 | 1703.4172 |
| 0043 | 0.0175 | -41.143 | 71443.5247 | 1360.3986 |
| 0044 | 0.0138 | -33.649 | 78164.5029 | 1070.8527 |
| 0045 | 0.0108 | -25.569 | 83132.8922 | 839.9940 |
| 0046 | 0.0087 | -17.084 | 86262.7601 | 671.7189 |
| 0047 | 0.0074 | -8.380 | 87508.5542 | 568.5384 |
| 0048 | 0.0070 | 0.354 | 86865.6057 | 531.5396 |

| | | | | |
|--------|--------|--------|------------|-----------|
| 0.0049 | 0.0075 | 8.931 | 84369.7520 | 560.3796 |
| 0.0050 | 0.0088 | 17.169 | 80096.0958 | 653.3096 |
| 0.0051 | 0.0109 | 24.895 | 74156.9379 | 807.2283 |
| 0.0052 | 0.0137 | 31.949 | 66698.9375 | 1017.7646 |
| 0.0053 | 0.0173 | 38.189 | 57899.5692 | 1279.3859 |
| 0.0054 | 0.0213 | 43.491 | 47962.9630 | 1585.5301 |

MAXIMUM DEFLECTION

TIME

0.0981

0.0026

INPUT DATA FOR WINBLAST PROGRAM:

BLAST PRESSURE = 14.6 psi
 BLAST DURATION = 26 msec
 GLASS THICKNESS = .71 in.
 WINDOW SIZE = 36 x 36
 ASPECT RATIO = 1
 DAMPING PERCENTAGE = 4 %

| TIME (sec) | DISPLACEMENT (in) | VELOCITY (in/sec) | ACCELERATION (in/sec2) | STRESS (psi) |
|---------------|----------------------|----------------------|---------------------------|-----------------|
| ----- | ----- | ----- | ----- | ----- |
| 0001 | 0.0000 | 0.745 | 13521.0465 | 0.8064 |
| 0002 | 0.0002 | 2.768 | 26910.5095 | 5.8842 |
| 0003 | 0.0006 | 6.120 | 40103.6455 | 19.9209 |
| 0004 | 0.0015 | 10.780 | 53040.8399 | 47.5465 |
| 0005 | 0.0028 | 16.718 | 65663.9780 | 93.3030 |
| 0006 | 0.0048 | 23.900 | 77916.7046 | 161.6246 |
| 0007 | 0.0076 | 32.287 | 89744.6736 | 256.8178 |
| 0008 | 0.0113 | 41.833 | 101095.7868 | 383.0419 |
| 0009 | 0.0160 | 52.488 | 111920.4217 | 544.2911 |
| 0010 | 0.0219 | 64.198 | 122171.6459 | 744.3769 |
| 0011 | 0.0289 | 76.198 | 117736.2654 | 986.3111 |
| 0012 | 0.0371 | 87.728 | 112783.4209 | 1269.6551 |
| 0013 | 0.0464 | 98.738 | 107338.6959 | 1592.6924 |
| 0014 | 0.0568 | 109.180 | 101429.7977 | 1953.5324 |
| 0015 | 0.0682 | 119.009 | 95086.4183 | 2350.1209 |
| 0016 | 0.0806 | 128.184 | 88340.0869 | 2780.2507 |
| 0017 | 0.0939 | 136.665 | 81224.0155 | 3241.5717 |
| 0018 | 0.1079 | 144.417 | 73772.9362 | 3731.6037 |
| 0019 | 0.1227 | 151.409 | 66022.9339 | 4247.7474 |
| 0020 | 0.1382 | 157.613 | 58011.2729 | 4787.2979 |
| 0021 | 0.1542 | 163.004 | 49776.2187 | 5347.4569 |
| 0022 | 0.1707 | 167.562 | 41356.8572 | 5925.3469 |
| 0023 | 0.1877 | 171.271 | 32792.9098 | 6518.0241 |
| 0024 | 0.2050 | 174.117 | 24124.5481 | 7122.4928 |
| 0025 | 0.2225 | 176.094 | 15392.2057 | 7735.7193 |
| 0026 | 0.2402 | 177.195 | 6636.3919 | 8354.6460 |
| 0027 | 0.2579 | 177.421 | -2102.4960 | 8976.2057 |
| 0028 | 0.2756 | 176.776 | -10784.3573 | 9597.3358 |
| 0029 | 0.2932 | 175.268 | -19369.5709 | 10214.9920 |
| 0030 | 0.3106 | 172.907 | -27819.1748 | 10826.1628 |
| 0031 | 0.3278 | 169.672 | -36949.9358 | 11442.9939 |
| 0032 | 0.3445 | 165.540 | -45645.4524 | 12057.7298 |
| 0033 | 0.3609 | 160.550 | -54114.9431 | 12656.0934 |
| 0034 | 0.3766 | 154.727 | -62312.4721 | 13234.9796 |
| 0035 | 0.3918 | 148.098 | -70192.9655 | 13791.3812 |
| 0036 | 0.4062 | 140.657 | -78703.9772 | 14323.6468 |
| 0037 | 0.4199 | 132.419 | -85982.2086 | 14828.6516 |
| 0038 | 0.4327 | 123.476 | -92805.9832 | 15302.3328 |
| 0039 | 0.4446 | 113.875 | -99134.1112 | 15742.1664 |
| 0040 | 0.4554 | 103.667 | -104928.1916 | 16145.8093 |
| 0041 | 0.4653 | 92.908 | -110152.9962 | 16511.1130 |
| 0042 | 0.4740 | 81.656 | -114776.8292 | 16836.1371 |
| 0043 | 0.4816 | 69.974 | -118771.8549 | 17119.1606 |
| 0044 | 0.4880 | 57.924 | -122114.3880 | 17358.6925 |
| 0045 | 0.4932 | 45.573 | -124785.1423 | 17553.4809 |
| 0046 | 0.4971 | 32.918 | -128381.4074 | 17702.3372 |
| 0047 | 0.4997 | 20.008 | -129697.1353 | 17804.1355 |
| 0048 | 0.5011 | 7.003 | -130280.0560 | 17858.4388 |

| | | | | |
|-------|--------|----------|--------------|------------|
| .0049 | 0.5011 | -6.023 | -130129.9149 | 17865.0064 |
| .0050 | 0.4999 | -18.999 | -129251.9352 | 17823.8664 |
| .0051 | 0.4973 | -31.850 | -127656.7444 | 17735.3139 |
| .0052 | 0.4935 | -44.467 | -123810.2596 | 17599.8256 |
| .0053 | 0.4885 | -56.710 | -120933.5901 | 17418.3321 |
| .0054 | 0.4822 | -68.633 | -117427.9629 | 17192.2997 |
| .0055 | 0.4747 | -80.175 | -113320.9009 | 16922.9930 |
| .0056 | 0.4662 | -91.278 | -108643.6725 | 16611.8990 |
| .0057 | 0.4565 | -101.886 | -103430.9529 | 16260.7148 |
| .0058 | 0.4458 | -111.948 | -97720.4565 | 15871.3361 |
| .0059 | 0.4341 | -121.415 | -91552.5452 | 15445.8423 |
| .0060 | 0.4215 | -130.244 | -84969.8200 | 14986.4829 |
| .0061 | 0.4081 | -138.396 | -78016.7009 | 14495.6609 |
| .0062 | 0.3939 | -145.824 | -69903.0925 | 13976.3288 |
| .0063 | 0.3790 | -152.447 | -62520.6638 | 13433.1149 |
| .0064 | 0.3634 | -158.320 | -54906.6418 | 12866.7688 |
| .0065 | 0.3473 | -163.422 | -47105.5667 | 12280.0661 |
| .0066 | 0.3308 | -167.737 | -39161.9492 | 11675.8525 |
| .0067 | 0.3138 | -171.249 | -30673.8468 | 11057.9997 |
| .0068 | 0.2965 | -173.939 | -23105.0705 | 10453.8570 |
| .0069 | 0.2791 | -175.868 | -15471.0437 | 9841.3521 |
| .0070 | 0.2614 | -177.032 | -7807.2309 | 9223.1580 |
| .0071 | 0.2437 | -177.430 | -149.0414 | 8601.9589 |
| .0072 | 0.2259 | -177.063 | 7468.3332 | 7980.4385 |
| .0073 | 0.2083 | -175.939 | 15010.0799 | 7361.2674 |
| .0074 | 0.1908 | -174.065 | 22441.9220 | 6747.0909 |
| .0075 | 0.1735 | -171.455 | 29730.2742 | 6140.5169 |

MAXIMUM DEFLECTION

TIME

0.5013

0.0048

INPUT DATA FOR WINBLAST PROGRAM:

BLAST PRESSURE = 7.3 psi
 BLAST DURATION = 26 msec
 GLASS THICKNESS = .355 in.
 WINDOW SIZE = 36 x 36
 ASPECT RATIO = 1
 DAMPING PERCENTAGE = 4 %

| TIME (sec) | DISPLACEMENT (in) | VELOCITY (in/sec) | ACCELERATION (in/sec2) | STRESS (psi) |
|---------------|----------------------|----------------------|---------------------------|-----------------|
| ----- | ----- | ----- | ----- | ----- |
| 0.0001 | 0.0000 | 0.746 | 13551.5534 | 0.4036 |
| 0.0002 | 0.0002 | 2.776 | 27052.6218 | 2.9484 |
| 0.0003 | 0.0006 | 6.154 | 40485.9017 | 9.9966 |
| 0.0004 | 0.0015 | 10.871 | 53836.1059 | 23.9032 |
| 0.0005 | 0.0028 | 16.918 | 67088.0842 | 47.0089 |
| 0.0006 | 0.0049 | 24.285 | 80226.8405 | 81.6376 |
| 0.0007 | 0.0077 | 32.959 | 93237.5501 | 130.0934 |
| 0.0008 | 0.0115 | 42.927 | 106105.5758 | 194.6583 |
| 0.0009 | 0.0164 | 54.175 | 118816.4843 | 277.5897 |
| 0.0010 | 0.0224 | 66.685 | 131356.0628 | 381.1176 |
| 0.0011 | 0.0297 | 79.735 | 129613.9403 | 507.1417 |
| 0.0012 | 0.0384 | 92.603 | 127727.2665 | 655.9074 |
| 0.0013 | 0.0482 | 105.275 | 125698.6067 | 827.0870 |
| 0.0014 | 0.0594 | 117.738 | 123530.6825 | 1020.3275 |
| 0.0015 | 0.0718 | 129.977 | 121226.3686 | 1235.2515 |
| 0.0016 | 0.0854 | 141.979 | 118788.6889 | 1471.4577 |
| 0.0017 | 0.1002 | 153.730 | 116220.8128 | 1728.5212 |
| 0.0018 | 0.1161 | 165.219 | 113526.0510 | 2005.9944 |
| 0.0019 | 0.1332 | 176.431 | 110707.8514 | 2303.4073 |
| 0.0020 | 0.1514 | 187.356 | 107769.7946 | 2620.2682 |
| 0.0021 | 0.1707 | 197.973 | 104490.9734 | 2964.1610 |
| 0.0022 | 0.1910 | 208.249 | 101001.5725 | 3333.7453 |
| 0.0023 | 0.2123 | 218.160 | 97170.2008 | 3722.8580 |
| 0.0024 | 0.2346 | 227.682 | 93242.7344 | 4130.7742 |
| 0.0025 | 0.2578 | 236.794 | 88873.5616 | 4555.5586 |
| 0.0026 | 0.2819 | 245.462 | 84451.6232 | 4996.0843 |
| 0.0027 | 0.3069 | 253.678 | 79833.5812 | 5452.1720 |
| 0.0028 | 0.3327 | 261.378 | 74451.4317 | 5917.8981 |
| 0.0029 | 0.3592 | 268.563 | 69216.1220 | 6397.1213 |
| 0.0030 | 0.3864 | 275.184 | 63059.6342 | 6883.9328 |
| 0.0031 | 0.4142 | 281.195 | 57124.6247 | 7376.8175 |
| 0.0032 | 0.4426 | 286.602 | 50963.0802 | 7879.9474 |
| 0.0033 | 0.4715 | 291.294 | 43424.3254 | 8408.3681 |
| 0.0034 | 0.5008 | 295.292 | 36505.0391 | 8947.7051 |
| 0.0035 | 0.5305 | 298.581 | 28053.5947 | 9496.0598 |
| 0.0036 | 0.5605 | 300.999 | 20285.4712 | 10085.8623 |
| 0.0037 | 0.5907 | 302.631 | 12307.6728 | 10679.8099 |
| 0.0038 | 0.6210 | 303.445 | 2265.5969 | 11279.8731 |
| 0.0039 | 0.6513 | 303.233 | -6530.2680 | 11923.4078 |
| 0.0040 | 0.6816 | 302.134 | -15477.2145 | 12565.7435 |
| 0.0041 | 0.7117 | 300.134 | -24542.1988 | 13204.9855 |
| 0.0042 | 0.7416 | 296.991 | -36642.5276 | 13990.8752 |
| 0.0043 | 0.7711 | 292.841 | -46363.2909 | 14798.5249 |
| 0.0044 | 0.8001 | 287.718 | -56092.2526 | 15593.7646 |
| 0.0045 | 0.8286 | 281.573 | -69174.0428 | 16398.6064 |
| 0.0046 | 0.8564 | 274.147 | -79333.7787 | 17317.0167 |
| 0.0047 | 0.8834 | 265.711 | -89347.7338 | 18209.6191 |
| 0.0048 | 0.9095 | 256.284 | -99159.8612 | 19073.1093 |

| | | | | |
|--------|--------|----------|--------------|------------|
| 0.0049 | 0.9346 | 245.888 | -108714.0016 | 19904.2478 |
| 0.0050 | 0.9586 | 234.212 | -122672.2122 | 20776.2513 |
| 0.0051 | 0.9814 | 221.474 | -132028.8176 | 21635.1159 |
| 0.0052 | 1.0029 | 207.822 | -140923.6684 | 22444.8618 |
| 0.0053 | 1.0230 | 193.306 | -149298.2774 | 23202.1392 |
| 0.0054 | 1.0415 | 177.982 | -157097.0689 | 23903.7912 |
| 0.0055 | 1.0585 | 161.908 | -164267.9614 | 24546.8744 |
| 0.0056 | 1.0739 | 145.014 | -176267.4276 | 25146.5070 |
| 0.0057 | 1.0875 | 127.076 | -182365.7067 | 25734.1562 |
| 0.0058 | 1.0993 | 108.569 | -187634.9397 | 26244.3582 |
| 0.0059 | 1.1092 | 89.578 | -192037.1604 | 26674.8324 |
| 0.0060 | 1.1172 | 70.191 | -195541.2338 | 27023.6664 |
| 0.0061 | 1.1232 | 50.500 | -198123.2113 | 27289.3288 |
| 0.0062 | 1.1273 | 30.598 | -199766.5981 | 27470.6801 |
| 0.0063 | 1.1294 | 10.579 | -200462.5311 | 27566.9802 |
| 0.0064 | 1.1294 | -9.463 | -200209.8640 | 27577.8920 |
| 0.0065 | 1.1275 | -29.431 | -199015.1588 | 27503.4826 |
| 0.0066 | 1.1235 | -49.234 | -196892.5860 | 27344.2208 |
| 0.0067 | 1.1176 | -68.780 | -193863.7341 | 27100.9714 |
| 0.0068 | 1.1098 | -87.978 | -189957.3315 | 26774.9859 |
| 0.0069 | 1.1000 | -106.743 | -185208.8873 | 26367.8912 |
| 0.0070 | 1.0885 | -124.993 | -179660.2541 | 25881.6744 |
| 0.0071 | 1.0751 | -142.650 | -173359.1216 | 25318.6654 |
| 0.0072 | 1.0600 | -159.408 | -161281.0732 | 24719.9138 |
| 0.0073 | 1.0432 | -175.182 | -154106.7324 | 24098.6935 |
| 0.0074 | 1.0249 | -190.212 | -146395.8978 | 23419.4621 |

MAXIMUM DEFLECTION

TIME

1.1296

0.0063

INPUT DATA FOR WINBLAST PROGRAM:

BLAST PRESSURE = 14.6 psi
 BLAST DURATION = 26 msec
 GLASS THICKNESS = .8090000000000001 in.
 WINDOW SIZE = 36 x 36
 ASPECT RATIO = 1
 DAMPING PERCENTAGE = 4 %

| TIME (sec) | DISPLACEMENT (in) | VELOCITY (in/sec) | ACCELERATION (in/sec2) | STRESS (psi) |
|---------------|----------------------|----------------------|---------------------------|-----------------|
| .0001 | 0.0000 | 0.653 | 11857.9055 | 0.8062 |
| .0002 | 0.0002 | 2.426 | 23575.7485 | 5.8801 |
| .0003 | 0.0006 | 5.361 | 35080.5570 | 19.8971 |
| .0004 | 0.0013 | 9.433 | 46304.9810 | 47.4588 |
| .0005 | 0.0025 | 14.611 | 57183.7602 | 93.0576 |
| .0006 | 0.0042 | 20.856 | 67654.0996 | 161.0506 |
| .0007 | 0.0067 | 28.126 | 77656.0297 | 255.6342 |
| .0008 | 0.0099 | 36.370 | 87132.7468 | 380.8205 |
| .0009 | 0.0140 | 45.533 | 96030.9324 | 540.4138 |
| .0010 | 0.0190 | 55.555 | 104301.0500 | 737.9899 |
| .0011 | 0.0251 | 65.753 | 99557.6566 | 976.2754 |
| .0012 | 0.0322 | 75.447 | 94249.3470 | 1254.4971 |
| .0013 | 0.0402 | 84.585 | 88411.2898 | 1570.5592 |
| .0014 | 0.0491 | 93.113 | 82081.5984 | 1922.1522 |
| .0015 | 0.0588 | 100.986 | 75301.0851 | 2306.7687 |
| .0016 | 0.0692 | 108.160 | 68113.0009 | 2721.7197 |
| .0017 | 0.0804 | 114.596 | 60562.7623 | 3164.1518 |
| .0018 | 0.0921 | 120.262 | 52697.6672 | 3631.0652 |
| .0019 | 0.1044 | 125.127 | 44566.6006 | 4119.3324 |
| .0020 | 0.1171 | 129.168 | 36219.7329 | 4625.7179 |
| .0021 | 0.1302 | 132.365 | 27708.2133 | 5146.8979 |
| .0022 | 0.1436 | 134.706 | 19083.8577 | 5679.4809 |
| .0023 | 0.1571 | 136.180 | 10398.8355 | 6220.0283 |
| .0024 | 0.1708 | 136.785 | 1705.3565 | 6765.0752 |
| .0025 | 0.1845 | 136.523 | -6944.6415 | 7311.1510 |
| .0026 | 0.1981 | 135.399 | -15499.8007 | 7854.8007 |
| .0027 | 0.2115 | 133.428 | -23909.6465 | 8392.6050 |
| .0028 | 0.2247 | 130.624 | -32124.8829 | 8921.2004 |
| .0029 | 0.2376 | 127.011 | -40097.6798 | 9437.2994 |
| .0030 | 0.2501 | 122.614 | -47781.9493 | 9937.7092 |
| .0031 | 0.2621 | 117.466 | -55133.6098 | 10419.3505 |
| .0032 | 0.2736 | 111.600 | -62110.8371 | 10879.2748 |
| .0033 | 0.2844 | 105.057 | -68674.2999 | 11314.6816 |
| .0034 | 0.2945 | 97.880 | -74787.3792 | 11722.9339 |
| .0035 | 0.3040 | 90.116 | -80416.3698 | 12101.5732 |
| .0036 | 0.3126 | 81.814 | -85530.6641 | 12448.3328 |
| .0037 | 0.3203 | 73.028 | -90102.9150 | 12761.1502 |
| .0038 | 0.3271 | 63.813 | -94109.1795 | 13038.1782 |
| .0039 | 0.3330 | 54.226 | -97529.0402 | 13277.7949 |
| .0040 | 0.3380 | 44.327 | -100345.7058 | 13478.6114 |
| .0041 | 0.3419 | 34.177 | -102546.0886 | 13639.4789 |
| .0042 | 0.3448 | 23.839 | -104120.8598 | 13759.4944 |
| .0043 | 0.3467 | 13.374 | -105064.4822 | 13838.0041 |
| .0044 | 0.3475 | 2.847 | -105375.2196 | 13874.6059 |
| .0045 | 0.3472 | -7.680 | -105055.1238 | 13869.1505 |
| .0046 | 0.3459 | -18.143 | -104109.9988 | 13821.7404 |
| .0047 | 0.3436 | -28.481 | -102549.3436 | 13732.7279 |
| .0048 | 0.3403 | -38.633 | -100386.2717 | 13602.7115 |

| | | | | |
|--------|--------|----------|-------------|------------|
| C.0049 | 0.3359 | -48.539 | -97637.4116 | 13432.5305 |
| C.0050 | 0.3306 | -58.141 | -94322.7850 | 13223.2589 |
| C.0051 | 0.3243 | -67.385 | -90465.6669 | 12976.1975 |
| C.0052 | 0.3171 | -76.217 | -86092.4263 | 12692.8644 |
| C.0053 | 0.3091 | -84.587 | -81232.3498 | 12374.9848 |
| C.0054 | 0.3002 | -92.448 | -75917.4491 | 12024.4797 |
| C.0055 | 0.2906 | -99.757 | -70182.2525 | 11643.4527 |
| C.0056 | 0.2803 | -106.472 | -64063.5839 | 11234.1766 |
| C.0057 | 0.2693 | -112.558 | -57600.3285 | 10799.0790 |
| C.0058 | 0.2578 | -117.982 | -50833.1881 | 10340.7263 |
| C.0059 | 0.2457 | -122.716 | -43804.4270 | 9861.8081 |
| C.0060 | 0.2333 | -126.735 | -36557.6101 | 9365.1201 |
| C.0061 | 0.2204 | -130.021 | -29137.3347 | 8853.5467 |
| C.0062 | 0.2073 | -132.559 | -21588.9583 | 8330.0435 |
| C.0063 | 0.1939 | -134.336 | -13958.3228 | 7797.6188 |
| C.0064 | 0.1804 | -135.349 | -6291.4781 | 7259.3159 |
| C.0065 | 0.1669 | -135.595 | 1365.5938 | 6718.1941 |
| C.0066 | 0.1533 | -135.078 | 8967.2533 | 6177.3108 |
| C.0067 | 0.1399 | -133.805 | 16468.4732 | 5639.7032 |
| C.0068 | 0.1266 | -131.789 | 23825.1035 | 5108.3700 |
| C.0069 | 0.1136 | -129.046 | 30994.1298 | 4586.2540 |
| C.0070 | 0.1008 | -125.598 | 37933.9228 | 4076.2249 |
| C.0071 | 0.0885 | -121.468 | 44604.4785 | 3581.0625 |
| C.0072 | 0.0765 | -116.687 | 50967.6465 | 3103.4407 |
| C.0073 | 0.0651 | -111.286 | 56987.3465 | 2645.9123 |
| C.0074 | 0.0543 | -105.302 | 62629.7710 | 2210.8942 |

MAXIMUM DEFLECTION

TIME

0.3475

0.0044

INPUT DATA FOR WINBLAST PROGRAM:

BLAST PRESSURE = 14.6 psi
 BLAST DURATION = 26 msec
 GLASS THICKNESS = .71 in.
 WINDOW SIZE = 40 x 40
 ASPECT RATIO = 1
 DAMPING PERCENTAGE = 4 %

| TIME (sec) | DISPLACEMENT (in) | VELOCITY (in/sec) | ACCELERATION (in/sec2) | STRESS (psi) |
|---------------|----------------------|----------------------|---------------------------|-----------------|
| ----- | ----- | ----- | ----- | ----- |
| .0001 | 0.0000 | 0.745 | 13533.4379 | 0.6535 |
| .0002 | 0.0002 | 2.771 | 26969.6861 | 4.7704 |
| .0003 | 0.0006 | 6.134 | 40265.4899 | 16.1602 |
| .0004 | 0.0015 | 10.818 | 53381.3192 | 38.6008 |
| .0005 | 0.0028 | 16.803 | 66278.3607 | 75.8202 |
| .0006 | 0.0049 | 24.065 | 78918.6320 | 131.4854 |
| .0007 | 0.0077 | 32.577 | 91265.0931 | 209.1913 |
| .0008 | 0.0114 | 42.307 | 103281.7539 | 312.4509 |
| .0009 | 0.0162 | 53.221 | 114933.7779 | 444.6843 |
| .0010 | 0.0221 | 65.281 | 126187.5830 | 609.2093 |
| .0011 | 0.0293 | 77.740 | 122930.8010 | 808.7450 |
| .0012 | 0.0376 | 89.855 | 119317.1282 | 1043.2655 |
| .0013 | 0.0472 | 101.592 | 115359.0435 | 1311.7559 |
| .0014 | 0.0579 | 112.916 | 111070.0110 | 1613.1025 |
| .0015 | 0.0698 | 123.795 | 106464.4350 | 1946.0974 |
| .0016 | 0.0827 | 134.198 | 101557.6125 | 2309.4423 |
| .0017 | 0.0966 | 144.097 | 96365.6826 | 2701.7531 |
| .0018 | 0.1115 | 153.463 | 90905.5748 | 3121.5640 |
| .0019 | 0.1273 | 162.270 | 85194.9538 | 3567.3330 |
| .0020 | 0.1439 | 170.494 | 79252.1631 | 4037.4463 |
| .0021 | 0.1614 | 178.113 | 73096.1670 | 4530.2237 |
| .0022 | 0.1795 | 185.107 | 66746.4899 | 5043.9238 |
| .0023 | 0.1984 | 191.456 | 60223.1555 | 5576.7500 |
| .0024 | 0.2178 | 197.146 | 53546.6240 | 6126.8555 |
| .0025 | 0.2378 | 202.161 | 46737.7280 | 6692.3497 |
| .0026 | 0.2582 | 206.490 | 39817.6088 | 7271.3037 |
| .0027 | 0.2790 | 210.122 | 32807.6501 | 7861.7563 |
| .0028 | 0.3002 | 213.049 | 25729.4135 | 8461.7205 |
| .0029 | 0.3216 | 215.260 | 18188.2836 | 9073.2874 |
| .0030 | 0.3432 | 216.695 | 10485.6145 | 9712.8451 |
| .0031 | 0.3649 | 217.356 | 2726.2630 | 10355.7367 |
| .0032 | 0.3867 | 217.239 | -5063.9939 | 10999.6655 |
| .0033 | 0.4084 | 216.320 | -13535.9802 | 11643.5411 |
| .0034 | 0.4299 | 214.568 | -21491.9560 | 12285.5590 |
| .0035 | 0.4513 | 212.023 | -29403.7659 | 12921.4169 |
| .0036 | 0.4723 | 208.690 | -37241.0453 | 13548.7585 |
| .0037 | 0.4930 | 204.578 | -44972.9450 | 14165.2493 |
| .0038 | 0.5132 | 199.612 | -53825.6382 | 14767.4132 |
| .0039 | 0.5329 | 193.845 | -61486.2734 | 15353.5667 |
| .0040 | 0.5519 | 187.322 | -68945.3713 | 15921.6893 |
| .0041 | 0.5703 | 180.064 | -76168.7536 | 16469.5603 |
| .0042 | 0.5879 | 172.097 | -83122.6877 | 16995.0278 |
| .0043 | 0.6047 | 163.450 | -89774.1503 | 17496.0189 |
| .0044 | 0.6206 | 154.051 | -98014.9503 | 17967.4574 |
| .0045 | 0.6355 | 143.937 | -104196.6779 | 18408.2314 |
| .0046 | 0.6493 | 133.226 | -109963.2977 | 18818.5848 |
| .0047 | 0.6621 | 121.960 | -115283.8206 | 19196.8118 |
| .0048 | 0.6737 | 110.185 | -120129.5042 | 19541.3367 |

| | | | | |
|-------|--------|----------|--------------|------------|
| .0049 | 0.6841 | 97.951 | -124474.1312 | 19850.7226 |
| .0050 | 0.6933 | 85.308 | -128294.2659 | 20123.6788 |
| .0051 | 0.7012 | 72.310 | -131569.4856 | 20359.0679 |
| .0052 | 0.7078 | 59.013 | -134282.5831 | 20555.9121 |
| .0053 | 0.7130 | 45.473 | -136419.7380 | 20713.3981 |
| .0054 | 0.7168 | 31.748 | -137970.6537 | 20830.8812 |
| .0055 | 0.7193 | 17.899 | -138928.6586 | 20907.8887 |
| .0056 | 0.7204 | 3.983 | -139290.7697 | 20944.1219 |
| .0057 | 0.7201 | -9.940 | -139057.7184 | 20939.4569 |
| .0058 | 0.7184 | -23.809 | -138233.9375 | 20893.9445 |
| .0059 | 0.7154 | -37.567 | -136827.5096 | 20807.8094 |
| .0060 | 0.7109 | -51.155 | -134850.0793 | 20681.4473 |
| .0061 | 0.7051 | -64.518 | -132316.7280 | 20515.4222 |
| .0062 | 0.6980 | -77.601 | -129245.8155 | 20310.4616 |
| .0063 | 0.6896 | -90.350 | -125658.7899 | 20067.4517 |
| .0064 | 0.6800 | -102.716 | -121579.9680 | 19787.4306 |
| .0065 | 0.6691 | -114.651 | -117036.2912 | 19471.5816 |
| .0066 | 0.6571 | -126.109 | -112057.0579 | 19121.2255 |
| .0067 | 0.6439 | -137.049 | -106673.6388 | 18737.8118 |
| .0068 | 0.6297 | -147.431 | -100919.1769 | 18322.9094 |
| .0069 | 0.6144 | -157.221 | -94828.2780 | 17878.1974 |
| .0070 | 0.5982 | -166.280 | -86887.6134 | 17402.3573 |
| .0071 | 0.5812 | -174.652 | -80498.3676 | 16898.4295 |
| .0072 | 0.5633 | -182.373 | -73885.7878 | 16370.4074 |
| .0073 | 0.5447 | -189.423 | -67083.4001 | 15820.2478 |
| .0074 | 0.5255 | -195.784 | -60124.7581 | 15249.9649 |
| .0075 | 0.5056 | -201.443 | -53043.2038 | 14661.6203 |

MAXIMUM DEFLECTION

TIME

0.7205

0.0056



INPUT DATA FOR WINBLAST PROGRAM:

BLAST PRESSURE = 7.3 psi
 BLAST DURATION = 26 msec
 GLASS THICKNESS = .355 in.
 WINDOW SIZE = 40 x 40
 ASPECT RATIO = 1
 DAMPING PERCENTAGE = 4 %

| TIME (sec) | DISPLACEMENT (in) | VELOCITY (in/sec) | ACCELERATION (in/sec ²) | STRESS (psi) |
|---------------|----------------------|----------------------|--|-----------------|
| 00001 | 0.0000 | 0.746 | 13556.5818 | 0.3270 |
| 00002 | 0.0002 | 2.778 | 27074.6399 | 2.3891 |
| 00003 | 0.0006 | 6.159 | 40542.5168 | 8.1019 |
| 00004 | 0.0015 | 10.884 | 53950.1430 | 19.3777 |
| 00005 | 0.0029 | 16.947 | 67287.5168 | 38.1203 |
| 00006 | 0.0049 | 24.339 | 80544.7112 | 66.2238 |
| 00007 | 0.0078 | 33.053 | 93711.8821 | 105.5709 |
| 00008 | 0.0116 | 43.078 | 106779.2749 | 158.0317 |
| 00009 | 0.0164 | 54.405 | 119737.2317 | 225.4625 |
| 00010 | 0.0225 | 67.022 | 132576.1987 | 309.7038 |
| 00011 | 0.0298 | 80.211 | 131185.7698 | 412.3364 |
| 00012 | 0.0385 | 93.256 | 129699.2395 | 533.6080 |
| 00013 | 0.0485 | 106.147 | 128117.9427 | 673.3094 |
| 00014 | 0.0597 | 118.876 | 126443.2831 | 831.2174 |
| 00015 | 0.0723 | 131.433 | 124676.7315 | 1007.0957 |
| 00016 | 0.0860 | 143.808 | 122819.8254 | 1200.6949 |
| 00017 | 0.1010 | 155.994 | 120874.1669 | 1411.7527 |
| 00018 | 0.1172 | 167.980 | 118841.4216 | 1639.9941 |
| 00019 | 0.1346 | 179.759 | 116723.3177 | 1885.1320 |
| 00020 | 0.1532 | 191.322 | 114521.6436 | 2146.8669 |
| 00021 | 0.1729 | 202.653 | 112043.4124 | 2432.7726 |
| 00022 | 0.1937 | 213.727 | 109420.0954 | 2739.5301 |
| 00023 | 0.2156 | 224.526 | 106540.7037 | 3063.5711 |
| 00024 | 0.2386 | 235.033 | 103590.5139 | 3404.0332 |
| 00025 | 0.2626 | 245.230 | 100310.6911 | 3759.5238 |
| 00026 | 0.2876 | 255.096 | 96991.1137 | 4129.5757 |
| 00027 | 0.3136 | 264.617 | 93241.9592 | 4513.0846 |
| 00028 | 0.3405 | 273.753 | 89462.5390 | 4907.1426 |
| 00029 | 0.3683 | 282.504 | 85515.2414 | 5314.3946 |
| 00030 | 0.3970 | 290.811 | 80844.6947 | 5726.9306 |
| 00031 | 0.4265 | 298.672 | 76344.3631 | 6149.6858 |
| 00032 | 0.4567 | 306.051 | 70987.4037 | 6588.6533 |
| 00033 | 0.4877 | 312.896 | 65881.3325 | 7049.2011 |
| 00034 | 0.5193 | 319.221 | 60573.5820 | 7519.6486 |
| 00035 | 0.5515 | 324.941 | 53987.1251 | 8022.3536 |
| 00036 | 0.5843 | 330.040 | 47955.5032 | 8543.8145 |
| 00037 | 0.6175 | 334.525 | 41717.9926 | 9073.0170 |
| 00038 | 0.6511 | 338.244 | 33717.3720 | 9648.5111 |
| 00039 | 0.6851 | 341.268 | 26725.5359 | 10231.7550 |
| 00040 | 0.7194 | 343.574 | 17838.5489 | 10829.9532 |
| 00041 | 0.7538 | 344.971 | 10072.9925 | 11592.1908 |
| 00042 | 0.7883 | 345.583 | 2132.9035 | 12356.8302 |
| 00043 | 0.8229 | 345.393 | -5959.8558 | 13122.1164 |
| 00044 | 0.8574 | 344.157 | -16824.8564 | 14034.0515 |
| 00045 | 0.8917 | 342.035 | -25630.0697 | 14950.6595 |
| 00046 | 0.9258 | 339.028 | -34520.8991 | 15860.6600 |
| 00047 | 0.9595 | 334.992 | -46613.7347 | 16823.0589 |
| 00048 | 0.9927 | 329.858 | -56071.9140 | 17833.8804 |

| | | | | |
|-------|--------|----------|--------------|------------|
| .0049 | 1.0254 | 323.778 | -65516.7779 | 18827.9693 |
| .0050 | 1.0574 | 316.756 | -74908.1197 | 19802.4587 |
| .0051 | 1.0887 | 308.593 | -88113.7573 | 20823.7786 |
| .0052 | 1.1191 | 299.296 | -97802.9616 | 21876.4908 |
| .0053 | 1.1485 | 289.039 | -107301.6328 | 22895.7777 |
| .0054 | 1.1769 | 277.843 | -116561.8840 | 23878.3545 |
| .0055 | 1.2041 | 265.736 | -125536.2361 | 24821.0168 |
| .0056 | 1.2300 | 252.445 | -138985.5463 | 25793.6380 |
| .0057 | 1.2545 | 238.107 | -147702.3952 | 26762.0690 |
| .0058 | 1.2776 | 222.919 | -155960.2938 | 27672.8863 |
| .0059 | 1.2991 | 206.932 | -163711.1912 | 28522.8321 |
| .0060 | 1.3190 | 190.196 | -170909.6846 | 29308.8453 |
| .0061 | 1.3371 | 172.770 | -177513.4373 | 30028.0802 |
| .0062 | 1.3535 | 154.714 | -183483.5684 | 30677.9224 |
| .0063 | 1.3680 | 136.095 | -188785.0109 | 31256.0047 |
| .0064 | 1.3807 | 116.560 | -199085.2781 | 31810.5533 |
| .0065 | 1.3913 | 96.442 | -203153.4429 | 32294.1847 |
| .0066 | 1.4000 | 75.957 | -206405.9017 | 32687.4945 |
| .0067 | 1.4065 | 55.188 | -208823.2956 | 32988.9976 |
| .0068 | 1.4110 | 34.221 | -210392.1931 | 33197.5799 |
| .0069 | 1.4134 | 13.139 | -211105.2174 | 33312.5047 |
| .0070 | 1.4136 | -7.972 | -210961.1088 | 33333.4160 |
| .0071 | 1.4118 | -29.025 | -209964.7232 | 33260.3400 |
| .0072 | 1.4078 | -49.937 | -208126.9657 | 33093.6821 |
| .0073 | 1.4018 | -70.623 | -205464.6605 | 32834.2237 |
| .0074 | 1.3937 | -91.003 | -202000.3601 | 32483.1136 |
| .0075 | 1.3836 | -110.997 | -197762.0966 | 32041.8592 |
| .0076 | 1.3715 | -130.530 | -192783.0769 | 31512.3138 |
| .0077 | 1.3575 | -149.135 | -181961.5437 | 30955.2842 |
| .0078 | 1.3417 | -167.038 | -176006.1552 | 30341.7473 |
| .0079 | 1.3241 | -184.317 | -169482.4804 | 29658.9151 |
| .0080 | 1.3049 | -200.917 | -162434.0123 | 28909.3248 |
| .0081 | 1.2840 | -216.788 | -154906.8883 | 28095.7210 |
| .0082 | 1.2615 | -231.884 | -146949.4729 | 27221.0381 |
| .0083 | 1.2376 | -246.165 | -138611.9264 | 26288.3811 |
| .0084 | 1.2123 | -259.595 | -129945.7643 | 25301.0062 |

MAXIMUM DEFLECTION
TIME

1.4138

0.0070

INPUT DATA FOR WINBLAST PROGRAM:

BLAST PRESSURE = 14.6 psi
 BLAST DURATION = 26 msec
 GLASS THICKNESS = .8080000000000001 in.
 WINDOW SIZE = 40 x 40
 ASPECT RATIO = 1
 DAMPING PERCENTAGE = 4 %

| TIME (sec) | DISPLACEMENT (in) | VELOCITY (in/sec) | ACCELERATION (in/sec2) | STRESS (psi) |
|---------------|----------------------|----------------------|---------------------------|-----------------|
| .0001 | 0.0000 | 0.654 | 11885.7029 | 0.6533 |
| .0002 | 0.0002 | 2.433 | 23668.6842 | 4.7679 |
| .0003 | 0.0006 | 5.383 | 35300.2689 | 16.1462 |
| .0004 | 0.0013 | 9.487 | 46735.7440 | 38.5501 |
| .0005 | 0.0025 | 14.722 | 57931.3862 | 75.6798 |
| .0006 | 0.0043 | 21.064 | 68844.6287 | 131.1593 |
| .0007 | 0.0067 | 28.480 | 79434.2209 | 208.5228 |
| .0008 | 0.0100 | 36.938 | 89660.3837 | 311.2013 |
| .0009 | 0.0142 | 46.399 | 99484.9574 | 442.5098 |
| .0010 | 0.0193 | 56.821 | 108871.5428 | 605.6345 |
| .0011 | 0.0255 | 67.538 | 105418.8348 | 803.1355 |
| .0012 | 0.0328 | 77.891 | 101571.2805 | 1034.7987 |
| .0013 | 0.0411 | 87.840 | 97345.8935 | 1299.3948 |
| .0014 | 0.0504 | 97.348 | 92761.0791 | 1595.5713 |
| .0015 | 0.0605 | 106.381 | 87836.5558 | 1921.8588 |
| .0016 | 0.0716 | 114.905 | 82593.2718 | 2276.6776 |
| .0017 | 0.0835 | 122.889 | 77053.3163 | 2658.3446 |
| .0018 | 0.0962 | 130.306 | 71239.8282 | 3065.0797 |
| .0019 | 0.1096 | 137.129 | 65176.8998 | 3495.0142 |
| .0020 | 0.1236 | 143.334 | 58889.4783 | 3946.1976 |
| .0021 | 0.1382 | 148.900 | 52403.2638 | 4416.6064 |
| .0022 | 0.1533 | 153.809 | 45744.6051 | 4904.1519 |
| .0023 | 0.1689 | 158.044 | 38940.3934 | 5406.6889 |
| .0024 | 0.1849 | 161.593 | 32017.9546 | 5922.0243 |
| .0025 | 0.2012 | 164.445 | 25004.9402 | 6447.9258 |
| .0026 | 0.2178 | 166.592 | 17929.2177 | 6982.1313 |
| .0027 | 0.2345 | 168.030 | 10818.7603 | 7522.3571 |
| .0028 | 0.2514 | 168.756 | 3701.5375 | 8066.3077 |
| .0029 | 0.2683 | 168.771 | -3394.5948 | 8611.6844 |
| .0030 | 0.2851 | 168.078 | -10442.0021 | 9156.1944 |
| .0031 | 0.3018 | 166.685 | -17413.3786 | 9697.5597 |
| .0032 | 0.3184 | 164.599 | -24281.8520 | 10233.5261 |
| .0033 | 0.3347 | 161.833 | -31021.0867 | 10761.8716 |
| .0034 | 0.3508 | 158.400 | -37605.3836 | 11280.4153 |
| .0035 | 0.3664 | 154.298 | -44642.0476 | 11794.1324 |
| .0036 | 0.3816 | 149.499 | -51307.2308 | 12308.0154 |
| .0037 | 0.3963 | 144.044 | -57751.9759 | 12804.8292 |
| .0038 | 0.4104 | 137.957 | -63946.6639 | 13282.3939 |
| .0039 | 0.4239 | 131.264 | -69862.5626 | 13738.6132 |
| .0040 | 0.4366 | 123.995 | -75472.0234 | 14171.4836 |
| .0041 | 0.4486 | 116.181 | -80748.6750 | 14579.1041 |
| .0042 | 0.4598 | 107.807 | -86599.2634 | 14960.6644 |
| .0043 | 0.4702 | 98.912 | -91236.1600 | 15313.9386 |
| .0044 | 0.4796 | 89.574 | -95458.8022 | 15636.4687 |
| .0045 | 0.4881 | 79.835 | -99246.1230 | 15926.8104 |
| .0046 | 0.4956 | 69.740 | -102579.3613 | 16183.6662 |
| .0047 | 0.5020 | 59.335 | -105442.2211 | 16405.8919 |
| .0048 | 0.5074 | 48.668 | -107821.0108 | 16592.5019 |

| | | | | |
|-------|--------|----------|--------------|------------|
| .0049 | 0.5117 | 37.787 | -109704.7605 | 16742.6740 |
| .0050 | 0.5150 | 26.744 | -111085.3152 | 16855.7535 |
| .0051 | 0.5171 | 15.587 | -111957.4031 | 16931.2557 |
| .0052 | 0.5181 | 4.369 | -112318.6782 | 16968.8680 |
| .0053 | 0.5180 | -6.859 | -112169.7354 | 16968.4507 |
| .0054 | 0.5167 | -18.048 | -111514.0999 | 16930.0370 |
| .0055 | 0.5144 | -29.145 | -110358.1889 | 16853.8315 |
| .0056 | 0.5109 | -40.103 | -108711.2481 | 16740.2089 |
| .0057 | 0.5063 | -50.871 | -106585.2620 | 16589.7103 |
| .0058 | 0.5007 | -61.404 | -103994.8415 | 16403.0394 |
| .0059 | 0.4941 | -71.655 | -100957.0879 | 16181.0577 |
| .0060 | 0.4864 | -81.581 | -97491.4373 | 15924.7790 |
| .0061 | 0.4778 | -91.140 | -93619.4866 | 15635.3623 |
| .0062 | 0.4682 | -100.292 | -89364.8031 | 15314.1054 |
| .0063 | 0.4577 | -109.001 | -84752.7213 | 14962.4362 |
| .0064 | 0.4464 | -117.195 | -79020.7994 | 14582.7347 |
| .0065 | 0.4343 | -124.843 | -73897.5978 | 14177.1913 |
| .0066 | 0.4215 | -131.966 | -68505.2815 | 13746.5658 |
| .0067 | 0.4079 | -138.536 | -62872.0425 | 13292.6668 |
| .0068 | 0.3938 | -144.533 | -57026.7507 | 12817.3848 |
| .0069 | 0.3790 | -149.936 | -50998.7577 | 12322.6830 |
| .0070 | 0.3638 | -154.728 | -44817.7028 | 11810.5869 |
| .0071 | 0.3481 | -158.874 | -38330.2154 | 11297.4024 |
| .0072 | 0.3320 | -162.408 | -32330.8765 | 10779.4284 |
| .0073 | 0.3157 | -165.337 | -26235.1266 | 10250.8170 |
| .0074 | 0.2990 | -167.653 | -20067.2766 | 9713.5341 |

MAXIMUM DEFLECTION

TIME

0.5182

0.0052

APPENDIX D: This appendix presents a summary of the ABAQUS output. The output has been reduced to simply show a time verses deflection table.

The ABAQUS output included in this appendix is as shown on the following page.

| <u>WINDOW SIZE</u> | <u>THICKNESS</u> | <u>LOAD</u> | <u>PAGE NO.</u> |
|--------------------|------------------|-------------|-----------------|
| 26 x 26 | 0.71 | 14.6 | D-3 |
| 36 x 36 | 0.71 | 14.6 | D-4 |
| 40 x 40 | 0.71 | 14.6 | D-5 |
| 72 x 72 | 1.06 | 14.6 | D-6 |
| 72 x 72 | 1.06 | 30.0 | D-7 |
| 72 x 72 | 1.06 | 40.0 | D-8 |
| 72 x 72 | 1.06 | 50.0 | D-9 |
| 27 x 20 | 0.71 | 14.6 | D-10 |
| 32 x 20 | 0.71 | 14.6 | D-11 |
| 72 x 24 | 0.71 | 14.6 | D-12 |
| 72 x 24 | 0.71 | 75.0 | D-13 |

Reduced ABAQUS Output

Blast Deflections of a 26" x 26" heat-treated glass plate
Thickness = 0.71"
Load = 14.6 psi

| Time (Milliseconds) | Maximum Deflection (in.) |
|------------------------|-----------------------------|
| ----- | ----- |
| 1.0 | 0.01915 |
| 2.0 | 0.1091 |
| 2.8 | 0.1588 |
| 2.9 | 0.1599 |
| 3.0 | 0.1598 |
| 4.0 | 0.09545 |

Reduced ABAQUS Output

Blast Deflections of a 36" x 36" heat-treated glass plate
Thickness = 0.71"
Load = 14.6 psi

| Time (Milliseconds) | Maximum Deflection (in.) |
|------------------------|-----------------------------|
| ----- | ----- |
| 1.0 | 0.01477 |
| 2.0 | 0.1391 |
| 3.0 | 0.3243 |
| 4.0 | 0.4903 |
| 4.2 | 0.5140 |
| 4.4 | 0.5307 |
| 4.6 | 0.5396 |
| 4.8 | 0.5417 |
| 5.0 | 0.5385 |
| 6.0 | 0.4617 |

Reduced ABAQUS Output

Blast Deflections of a 40" x 40" heat-treated glass plate
Thickness = 0.71"
Load = 14.6 psi

| Time (Milliseconds) | Maximum Deflection (in.) |
|------------------------|-----------------------------|
| ----- | ----- |
| 1.0 | 0.01375 |
| 2.0 | 0.1327 |
| 3.0 | 0.3618 |
| 4.0 | 0.5702 |
| 5.0 | 0.7434 |
| 5.1 | 0.7532 |
| 5.2 | 0.7608 |
| 5.3 | 0.7662 |
| 5.4 | 0.7694 |
| 5.5 | 0.7706 |
| 5.6 | 0.7699 |
| 6.0 | 0.7532 |
| 7.0 | 0.6460 |

Reduced ABAQUS Output

Blast Deflections of a 72" x 72" heat-treated glass plate
Thickness = 1.06"
Load = 14.6 psi

| Time (Milliseconds) | Maximum Deflection (in.) |
|------------------------|-----------------------------|
| ----- | ----- |
| 1.0 | 0.00967 |
| 2.0 | 0.06167 |
| 3.0 | 0.2053 |
| 4.0 | 0.4719 |
| 5.0 | 0.8056 |
| 6.0 | 1.106 |
| 7.0 | 1.352 |
| 7.2 | 1.398 |
| 7.4 | 1.442 |
| 7.6 | 1.485 |
| 7.8 | 1.527 |
| 8.0 | 1.568 |
| 8.2 | 1.610 |
| 8.4 | 1.651 |
| 8.6 | 1.692 |
| 8.8 | 1.732 |
| 9.0 | 1.770 |
| 9.1 | 1.788 |
| 9.2 | 1.805 |
| 9.3 | 1.820 |
| 9.4 | 1.834 |
| 9.5 | 1.847 |
| 9.6 | 1.858 |
| 9.7 | 1.867 |
| 9.8 | 1.875 |
| 9.9 | 1.880 |
| 10.0 | 1.884 |
| 10.1 | 1.887 |
| 10.2 | 1.888 |
| 10.3 | 1.887 |
| 11.0 | 1.840 |
| 12.0 | 1.662 |

Reduced ABAQUS Output

Blast Deflections of a 72" x 72" heat-treated glass plate
Thickness = 1.06"
Load = 30.0 psi

| Time (Milliseconds) | Maximum Deflection (in.) |
|------------------------|-----------------------------|
| ----- | ----- |
| 1.0 | 0.01986 |
| 2.0 | 0.1267 |
| 3.0 | 0.4220 |
| 4.0 | 0.9689 |
| 5.0 | 1.630 |
| 6.0 | 2.141 |
| 7.0 | 2.485 |
| 7.2 | 2.546 |
| 7.4 | 2.604 |
| 7.6 | 2.662 |
| 7.8 | 2.718 |
| 8.0 | 2.774 |
| 8.2 | 2.829 |
| 8.4 | 2.881 |
| 8.6 | 2.929 |
| 8.8 | 2.967 |
| 9.0 | 2.993 |
| 9.1 | 3.000 |
| 9.2 | 3.003 |
| 9.3 | 3.001 |
| 10.0 | 2.861 |
| 11.0 | 2.416 |
| 12.0 | 1.900 |

Reduced ABAQUS Output

Blast Deflections of a 72" x 72" heat-treated glass plate
Thickness = 1.06"
Load = 40.0 psi

| Time (Milliseconds) | Maximum Deflection (in.) |
|------------------------|-----------------------------|
| ----- | ----- |
| 1.0 | 0.02648 |
| 2.0 | 0.1690 |
| 3.0 | 0.5628 |
| 4.0 | 1.291 |
| 5.0 | 2.142 |
| 6.0 | 2.714 |
| 7.0 | 3.062 |
| 8.0 | 3.386 |
| 8.1 | 3.415 |
| 8.2 | 3.443 |
| 8.3 | 3.469 |
| 8.4 | 3.491 |
| 8.5 | 3.509 |
| 8.6 | 3.523 |
| 8.7 | 3.532 |
| 8.8 | 3.535 |
| 8.9 | 3.531 |
| 9.0 | 3.520 |
| 10.0 | 3.086 |

Reduced ABAQUS Output

Blast Deflections of a 72" x 72" heat-treated glass plate
Thickness = 1.06"
Load = 50.0 psi

| Time (Milliseconds) | Maximum Deflection (in.) |
|------------------------|-----------------------------|
| ----- | ----- |
| 1.0 | 0.03310 |
| 2.0 | 0.2112 |
| 3.0 | 0.7037 |
| 4.0 | 1.509 |
| 5.0 | 2.628 |
| 6.0 | 3.212 |
| 7.0 | 3.558 |
| 8.0 | 3.746 |
| 9.0 | 3.920 |
| 9.1 | 3.946 |
| 9.2 | 3.967 |
| 9.3 | 3.982 |
| 9.4 | 3.990 |
| 9.5 | 3.991 |
| 9.6 | 3.984 |

Reduced ABAQUS Output

Blast Deflections of a 27" x 20" heat-treated glass plate

Thickness = 0.71"

Load = 14.6 psi

| Time (Milliseconds) | Maximum Deflection (in.) |
|------------------------|-----------------------------|
| ----- | ----- |
| 1.0 | 0.01861 |
| 2.0 | 0.08382 |
| 2.1 | 0.08781 |
| 2.2 | 0.09067 |
| 2.3 | 0.09229 |
| 2.4 | 0.09266 |
| 2.5 | 0.09181 |
| 3.0 | 0.07082 |
| 4.0 | 0.03212 |

Reduced ABAQUS Output

Blast Deflections of a 32" x 20" heat-treated glass plate
Thickness = 0.71"
Load = 14.6 psi

| Time (Milliseconds) | Maximum Deflection (in.) |
|------------------------|-----------------------------|
| ----- | ----- |
| 1.0 | 0.01805 |
| 2.0 | 0.09475 |
| 2.5 | 0.1138 |
| 2.6 | 0.1143 |
| 2.7 | 0.1138 |
| 3.0 | 0.1050 |
| 4.0 | 0.02545 |

Reduced ABAQUS Output

Blast Deflections of a 72" x 24" heat-treated glass plate
Thickness = 0.71"
Load = 14.6 psi

| Time (Milliseconds) | Maximum Deflection (in.) |
|------------------------|-----------------------------|
| ----- | ----- |
| 1.0 | 0.01693 |
| 2.0 | 0.1086 |
| 3.0 | 0.2538 |
| 4.0 | 0.3687 |
| 5.0 | 0.3726 |
| 6.0 | 0.3747 |
| 7.0 | 0.3749 |
| 7.2 | 0.3733 |
| 7.4 | 0.3290 |
| 7.6 | 0.1646 |
| 7.8 | -0.01163 |
| 8.0 | -0.06248 |

Reduced ABAQUS Output

Blast Deflections of a 72" x 24" heat-treated glass plate
Thickness = 0.71"
Load = 75.0 psi

| Time (Milliseconds) | Maximum Deflection (in.) |
|------------------------|-----------------------------|
| ----- | ----- |
| 1.0 | 0.08696 |
| 2.0 | 0.5585 |
| 3.0 | 1.341 |
| 3.1 | 1.422 |
| 3.2 | 1.498 |
| 3.3 | 1.566 |
| 3.4 | 1.625 |
| 3.5 | 1.675 |
| 3.6 | 1.716 |
| 3.7 | 1.749 |
| 3.8 | 1.776 |

ABAQUS Model developed instabilities at this point due to excessive rotations in 18 of it's elements.

APPENDIX E: This appendix presents the master data base used by WINBLAST. The data consist of nondimensional summaries for equivalent mass, equivalent load, maximum deflections, and maximum stress for monolithic glass plates. In developing these values, Poisson's ratio was taken to be 0.21 and a modified version of the Vallabhan-Wang solution (5) was employed. The solution technique allows the nonlinear plate equations to be solved using a finite difference technique which takes approximately 600 divisions for the solutions. The following pages present results for 21 different aspect ratios ranging from 1.0 to 5.0 by increments of 0.2.

The first column of each table contains the nondimensional pressure, \hat{q} . The dimensionalized pressure, q , can be determined using the following equation:

$$q = \hat{q} E h^2 / A^2 \quad (E1)$$

where E is the modulus of elasticity, h is the plate thickness, and A is the area of the glass plate. The nondimensional pressures vary from 9.97 to 14,044.69. All response values corresponding to a pressures less than 9.97 are within the linear response regime so that linear interpolation can be used.

The second column of each table presents the natural logarithm of the nondimensional load, $\ln[\hat{q}]$. The natural logarithms of the nondimensional pressures vary from 2.3 to 9.55 by increments of 0.25.

The third and fourth columns in the tables present the equivalent mass and load respectively.

The fifth and the sixth columns present the nondimensional maximum lateral deflection, $\hat{\delta}$, and the nondimensional maximum stress, $\hat{\sigma}$, respectively. The dimensionalized deflection, Δ , can be determined as follows:

$$\Delta = \hat{\delta}h \quad (E2)$$

and the dimensionalized maximum stress, σ , can be determined as follows:

$$\sigma = \hat{\sigma}h^2 / A \quad (E3)$$

where all of the factors are as previously defined.

Nondimensional Plate Data for Aspect Ratio = 1.0

| Nondimen- sional Later- al Pressure | Natural Log- arithm of Nondimen- sional Lat- eral Pressure | Mass Equivalency Factor | Load Equivalency Factor | Nondimen- sional Maxi- mum Deflection | Nondimen- sional Maxi- mum Stress |
|---|---|-------------------------------|-------------------------------|--|---|
| \hat{q} | $\ln[\hat{q}]$ | K_M | K_L | $\hat{\delta}$ | $\hat{\sigma}$ |
| 9.97 | 2.30 | 0.2646 | 0.4212 | 0.45 | 2.74 |
| 12.81 | 2.55 | 0.2659 | 0.4226 | 0.56 | 3.48 |
| 16.44 | 2.80 | 0.2678 | 0.4246 | 0.70 | 4.36 |
| 21.12 | 3.05 | 0.2704 | 0.4274 | 0.86 | 5.40 |
| 27.11 | 3.30 | 0.2739 | 0.4311 | 1.04 | 6.57 |
| 34.81 | 3.55 | 0.2784 | 0.4358 | 1.25 | 7.87 |
| 44.70 | 3.80 | 0.2839 | 0.4416 | 1.48 | 9.36 |
| 57.40 | 4.05 | 0.2904 | 0.4483 | 1.73 | 11.11 |
| 73.70 | 4.30 | 0.2979 | 0.4560 | 2.01 | 13.17 |
| 94.63 | 4.55 | 0.3062 | 0.4645 | 2.31 | 16.07 |
| 121.51 | 4.80 | 0.3152 | 0.4735 | 2.65 | 19.92 |
| 156.02 | 5.05 | 0.3248 | 0.4831 | 3.01 | 24.72 |
| 200.34 | 5.30 | 0.3346 | 0.4928 | 3.41 | 30.75 |
| 257.24 | 5.55 | 0.3446 | 0.5026 | 3.86 | 38.31 |
| 330.30 | 5.80 | 0.3546 | 0.5123 | 4.35 | 47.82 |
| 424.11 | 6.05 | 0.3644 | 0.5218 | 4.90 | 59.74 |
| 544.57 | 6.30 | 0.3741 | 0.5310 | 5.50 | 74.67 |
| 699.24 | 6.55 | 0.3835 | 0.5399 | 6.16 | 93.34 |
| 897.85 | 6.80 | 0.3928 | 0.5485 | 6.89 | 117.15 |
| 1,152.86 | 7.05 | 0.4019 | 0.5570 | 7.70 | 147.92 |
| 1,480.30 | 7.30 | 0.4109 | 0.5652 | 8.58 | 186.77 |
| 1,900.74 | 7.55 | 0.4197 | 0.5732 | 9.55 | 235.59 |
| 2,440.60 | 7.80 | 0.4286 | 0.5812 | 10.61 | 296.47 |
| 3,133.79 | 8.05 | 0.4373 | 0.5890 | 11.77 | 371.64 |
| 4,023.87 | 8.30 | 0.4459 | 0.5967 | 13.04 | 463.13 |
| 5,166.75 | 8.55 | 0.4543 | 0.6041 | 14.43 | 573.26 |
| 6,634.24 | 8.80 | 0.4624 | 0.6113 | 15.94 | 733.82 |
| 8,518.54 | 9.05 | 0.4703 | 0.6184 | 17.60 | 926.45 |
| 10,938.02 | 9.30 | 0.4781 | 0.6254 | 19.41 | 1,148.60 |
| 14,044.69 | 9.55 | 0.4859 | 0.6323 | 21.38 | 1,470.70 |

Nondimensional Plate Data for Aspect Ratio = 1.2

| Nondimen- sional Later- al Pressure | Natural Log- arithm of Nondimen- sional Lat- eral Pressure | Mass Equivalency Factor | Load Equivalency Factor | Nondimen- sional Maxi- mum Deflection | Nondimen- sional Maxi- mum Stress |
|---|---|-------------------------------|-------------------------------|--|---|
| \hat{q} | $\ln[\hat{q}]$ | K_M | K_L | $\hat{\delta}$ | $\hat{\sigma}$ |
| 9.97 | 2.30 | 0.2653 | 0.4220 | 0.43 | 3.00 |
| 12.81 | 2.55 | 0.2665 | 0.4232 | 0.54 | 3.80 |
| 16.44 | 2.80 | 0.2682 | 0.4251 | 0.68 | 4.76 |
| 21.12 | 3.05 | 0.2707 | 0.4277 | 0.84 | 5.90 |
| 27.11 | 3.30 | 0.2741 | 0.4313 | 1.03 | 7.19 |
| 34.81 | 3.55 | 0.2784 | 0.4358 | 1.24 | 8.61 |
| 44.70 | 3.80 | 0.2837 | 0.4413 | 1.47 | 10.13 |
| 57.40 | 4.05 | 0.2900 | 0.4478 | 1.73 | 11.79 |
| 73.70 | 4.30 | 0.2971 | 0.4552 | 2.01 | 13.72 |
| 94.63 | 4.55 | 0.3050 | 0.4633 | 2.32 | 15.99 |
| 121.51 | 4.80 | 0.3135 | 0.4719 | 2.65 | 19.83 |
| 156.02 | 5.05 | 0.3224 | 0.4809 | 3.03 | 24.61 |
| 200.34 | 5.30 | 0.3316 | 0.4902 | 3.44 | 30.61 |
| 257.24 | 5.55 | 0.3410 | 0.4995 | 3.89 | 38.14 |
| 330.30 | 5.80 | 0.3503 | 0.5087 | 4.39 | 47.61 |
| 424.11 | 6.05 | 0.3597 | 0.5178 | 4.94 | 59.48 |
| 544.57 | 6.30 | 0.3689 | 0.5268 | 5.55 | 74.37 |
| 699.24 | 6.55 | 0.3781 | 0.5355 | 6.23 | 92.98 |
| 897.85 | 6.80 | 0.3872 | 0.5440 | 6.97 | 116.58 |
| 1,152.86 | 7.05 | 0.3961 | 0.5524 | 7.78 | 147.26 |
| 1,480.30 | 7.30 | 0.4051 | 0.5607 | 8.68 | 186.03 |
| 1,900.74 | 7.55 | 0.4141 | 0.5688 | 9.66 | 234.81 |
| 2,440.60 | 7.80 | 0.4231 | 0.5769 | 10.73 | 295.73 |
| 3,133.79 | 8.05 | 0.4320 | 0.5849 | 11.90 | 371.06 |
| 4,023.87 | 8.30 | 0.4408 | 0.5927 | 13.18 | 462.94 |
| 5,166.75 | 8.55 | 0.4493 | 0.6002 | 14.58 | 573.31 |
| 6,634.24 | 8.80 | 0.4576 | 0.6067 | 16.12 | 730.37 |
| 8,518.54 | 9.05 | 0.4659 | 0.6149 | 17.79 | 924.60 |
| 10,938.02 | 9.30 | 0.4739 | 0.6220 | 19.62 | 1,151.30 |
| 14,044.69 | 9.55 | 0.4816 | 0.6289 | 21.62 | 1,459.20 |

Nondimensional Plate Data for Aspect Ratio = 1.4

| Nondimen- sional Later- al Pressure | Natural Log- arithm of Nondimen- sional Lat- eral Pressure | Mass Equivalency Factor | Load Equivalency Factor | Nondimen- sional Maxi- mum Deflection | Nondimen- sional Maxi- mum Stress |
|---|---|-------------------------------|-------------------------------|--|---|
| \hat{q} | $\ln[\hat{q}]$ | K_M | K_L | $\hat{\delta}$ | $\hat{\sigma}$ |
| 9.97 | 2.30 | 0.2671 | 0.4239 | 0.40 | 3.12 |
| 12.81 | 2.55 | 0.2680 | 0.4249 | 0.51 | 3.96 |
| 16.44 | 2.80 | 0.2695 | 0.4265 | 0.64 | 4.99 |
| 21.12 | 3.05 | 0.2717 | 0.4287 | 0.80 | 6.23 |
| 27.11 | 3.30 | 0.2746 | 0.4318 | 0.98 | 7.65 |
| 34.81 | 3.55 | 0.2785 | 0.4359 | 1.19 | 9.25 |
| 44.70 | 3.80 | 0.2833 | 0.4409 | 1.43 | 10.99 |
| 57.40 | 4.05 | 0.2889 | 0.4467 | 1.70 | 12.84 |
| 73.70 | 4.30 | 0.2953 | 0.4534 | 1.99 | 14.78 |
| 94.63 | 4.55 | 0.3022 | 0.4606 | 2.31 | 16.97 |
| 121.51 | 4.80 | 0.3096 | 0.4683 | 2.67 | 19.57 |
| 156.02 | 5.05 | 0.3173 | 0.4763 | 3.05 | 24.31 |
| 200.34 | 5.30 | 0.3253 | 0.4845 | 3.48 | 30.24 |
| 257.24 | 5.55 | 0.3334 | 0.4928 | 3.95 | 37.68 |
| 330.30 | 5.80 | 0.3416 | 0.5011 | 4.47 | 47.01 |
| 424.11 | 6.05 | 0.3498 | 0.5095 | 5.04 | 58.73 |
| 544.57 | 6.30 | 0.3581 | 0.5177 | 5.67 | 73.41 |
| 699.24 | 6.55 | 0.3665 | 0.5260 | 6.37 | 91.78 |
| 897.85 | 6.80 | 0.3751 | 0.5342 | 7.14 | 115.09 |
| 1,152.86 | 7.05 | 0.3837 | 0.5424 | 7.98 | 145.39 |
| 1,480.30 | 7.30 | 0.3925 | 0.5505 | 8.90 | 183.71 |
| 1,900.74 | 7.55 | 0.4015 | 0.5588 | 9.90 | 231.89 |
| 2,440.60 | 7.80 | 0.4106 | 0.5670 | 11.00 | 292.06 |
| 3,133.79 | 8.05 | 0.4197 | 0.5751 | 12.20 | 366.43 |
| 4,023.87 | 8.30 | 0.4288 | 0.5832 | 13.51 | 457.08 |
| 5,166.75 | 8.55 | 0.4377 | 0.5911 | 14.95 | 566.21 |
| 6,634.24 | 8.80 | 0.4465 | 0.5988 | 16.52 | 721.93 |
| 8,518.54 | 9.05 | 0.4553 | 0.6065 | 18.23 | 913.51 |
| 10,938.02 | 9.30 | 0.4637 | 0.6138 | 20.10 | 1,136.90 |
| 14,044.69 | 9.55 | 0.4719 | 0.6210 | 22.15 | 1,444.40 |

Nondimensional Plate Data for Aspect Ratio = 1.6

| Nondimen- sional Later- al Pressure | Natural Log- arithm of Nondimen- sional Lat- eral Pressure | Mass Equivalency Factor | Load Equivalency Factor | Nondimen- sional Maxi- mum Deflection | Nondimen- sional Maxi- mum Stress |
|---|---|-------------------------------|-------------------------------|--|---|
| \hat{q} | $\ln[\hat{q}]$ | K_M | K_L | $\hat{\delta}$ | $\hat{\sigma}$ |
| 9.97 | 2.30 | 0.2697 | 0.4267 | 0.36 | 3.14 |
| 12.81 | 2.55 | 0.2705 | 0.4275 | 0.46 | 4.00 |
| 16.44 | 2.80 | 0.2717 | 0.4287 | 0.59 | 5.07 |
| 21.12 | 3.05 | 0.2734 | 0.4305 | 0.74 | 6.37 |
| 27.11 | 3.30 | 0.2758 | 0.4330 | 0.92 | 7.92 |
| 34.81 | 3.55 | 0.2789 | 0.4363 | 1.13 | 9.70 |
| 44.70 | 3.80 | 0.2830 | 0.4406 | 1.37 | 11.71 |
| 57.40 | 4.05 | 0.2878 | 0.4456 | 1.65 | 13.89 |
| 73.70 | 4.30 | 0.2932 | 0.4513 | 1.95 | 16.22 |
| 94.63 | 4.55 | 0.2990 | 0.4575 | 2.29 | 18.68 |
| 121.51 | 4.80 | 0.3052 | 0.4641 | 2.66 | 21.29 |
| 156.02 | 5.05 | 0.3117 | 0.4710 | 3.07 | 24.35 |
| 200.34 | 5.30 | 0.3184 | 0.4781 | 3.52 | 29.66 |
| 257.24 | 5.55 | 0.3252 | 0.4854 | 4.01 | 36.98 |
| 330.30 | 5.80 | 0.3321 | 0.4927 | 4.56 | 46.16 |
| 424.11 | 6.05 | 0.3392 | 0.5002 | 5.15 | 57.70 |
| 544.57 | 6.30 | 0.3465 | 0.5077 | 5.81 | 72.17 |
| 699.24 | 6.55 | 0.3540 | 0.5153 | 6.54 | 90.28 |
| 897.85 | 6.80 | 0.3617 | 0.5230 | 7.34 | 113.05 |
| 1,152.86 | 7.05 | 0.3698 | 0.5307 | 8.21 | 142.91 |
| 1,480.30 | 7.30 | 0.3781 | 0.5387 | 9.17 | 180.72 |
| 1,900.74 | 7.55 | 0.3867 | 0.5467 | 10.21 | 228.35 |
| 2,440.60 | 7.80 | 0.3955 | 0.5548 | 11.35 | 287.97 |
| 3,133.79 | 8.05 | 0.4045 | 0.5629 | 12.60 | 361.89 |
| 4,023.87 | 8.30 | 0.4136 | 0.5711 | 13.96 | 452.37 |
| 5,166.75 | 8.55 | 0.4228 | 0.5792 | 15.44 | 561.33 |
| 6,634.24 | 8.80 | 0.4322 | 0.5874 | 17.06 | 711.66 |
| 8,518.54 | 9.05 | 0.4413 | 0.5954 | 18.82 | 903.53 |
| 10,938.02 | 9.30 | 0.4502 | 0.6031 | 20.75 | 1,127.90 |
| 14,044.69 | 9.55 | 0.4590 | 0.6107 | 22.86 | 1,420.90 |

Nondimensional Plate Data for Aspect Ratio = 1.8

| Nondimen- sional Later- al Pressure | Natural Log- arithm of Nondimen- sional Lat- eral Pressure | Mass Equivalency Factor | Load Equivalency Factor | Nondimen- sional Maxi- mum Deflection | Nondimen- sional Maxi- mum Stress |
|---|---|-------------------------------|-------------------------------|--|---|
| \hat{q} | $\ln[\hat{q}]$ | K_M | K_L | $\hat{\delta}$ | $\hat{\sigma}$ |
| 9.97 | 2.30 | 0.2734 | 0.4305 | 0.32 | 3.09 |
| 12.81 | 2.55 | 0.2739 | 0.4310 | 0.41 | 3.95 |
| 16.44 | 2.80 | 0.2746 | 0.4319 | 0.53 | 5.02 |
| 21.12 | 3.05 | 0.2759 | 0.4331 | 0.67 | 6.36 |
| 27.11 | 3.30 | 0.2776 | 0.4350 | 0.84 | 7.99 |
| 34.81 | 3.55 | 0.2801 | 0.4376 | 1.05 | 9.92 |
| 44.70 | 3.80 | 0.2833 | 0.4409 | 1.29 | 12.16 |
| 57.40 | 4.05 | 0.2871 | 0.4450 | 1.57 | 14.68 |
| 73.70 | 4.30 | 0.2915 | 0.4497 | 1.88 | 17.46 |
| 94.63 | 4.55 | 0.2963 | 0.4548 | 2.24 | 20.47 |
| 121.51 | 4.80 | 0.3014 | 0.4604 | 2.63 | 23.66 |
| 156.02 | 5.05 | 0.3067 | 0.4663 | 3.06 | 27.03 |
| 200.34 | 5.30 | 0.3122 | 0.4723 | 3.53 | 30.72 |
| 257.24 | 5.55 | 0.3179 | 0.4786 | 4.05 | 36.05 |
| 330.30 | 5.80 | 0.3238 | 0.4851 | 4.62 | 45.07 |
| 424.11 | 6.05 | 0.3299 | 0.4917 | 5.25 | 56.38 |
| 544.57 | 6.30 | 0.3363 | 0.4986 | 5.94 | 70.60 |
| 699.24 | 6.55 | 0.3429 | 0.5055 | 6.70 | 88.42 |
| 897.85 | 6.80 | 0.3498 | 0.5126 | 7.53 | 110.70 |
| 1,152.86 | 7.05 | 0.3571 | 0.5198 | 8.44 | 140.04 |
| 1,480.30 | 7.30 | 0.3647 | 0.5273 | 9.44 | 177.28 |
| 1,900.74 | 7.55 | 0.3726 | 0.5348 | 10.53 | 224.28 |
| 2,440.60 | 7.80 | 0.3808 | 0.5425 | 11.73 | 283.21 |
| 3,133.79 | 8.05 | 0.3893 | 0.5504 | 13.02 | 356.41 |
| 4,023.87 | 8.30 | 0.3981 | 0.5584 | 14.44 | 446.22 |
| 5,166.75 | 8.55 | 0.4072 | 0.5665 | 15.98 | 554.65 |
| 6,634.24 | 8.80 | 0.4166 | 0.5748 | 17.66 | 700.14 |
| 8,518.54 | 9.05 | 0.4260 | 0.5830 | 19.49 | 890.87 |
| 10,938.02 | 9.30 | 0.4353 | 0.5911 | 21.48 | 1,115.40 |
| 14,044.69 | 9.55 | 0.4446 | 0.5991 | 23.66 | 1,395.60 |

Nondimensional Plate Data for Aspect Ratio = 2.0

| Nondimen- sional Later- al Pressure | Natural Log- arithm of Nondimen- sional Lat- eral Pressure | Mass Equivalency Factor | Load Equivalency Factor | Nondimen- sional Maxi- mum Deflection | Nondimen- sional Maxi- mum Stress |
|---|---|-------------------------------|-------------------------------|--|---|
| \hat{q} | $\ln[\hat{q}]$ | K_M | K_L | $\hat{\delta}$ | $\hat{\sigma}$ |
| 9.97 | 2.30 | 0.2777 | 0.4350 | 0.29 | 2.99 |
| 12.81 | 2.55 | 0.2779 | 0.4353 | 0.37 | 3.83 |
| 16.44 | 2.80 | 0.2786 | 0.4359 | 0.47 | 4.89 |
| 21.12 | 3.05 | 0.2793 | 0.4367 | 0.60 | 6.23 |
| 27.11 | 3.30 | 0.2805 | 0.4380 | 0.76 | 7.89 |
| 34.81 | 3.55 | 0.2822 | 0.4397 | 0.95 | 9.91 |
| 44.70 | 3.80 | 0.2844 | 0.4421 | 1.19 | 12.32 |
| 57.40 | 4.05 | 0.2873 | 0.4452 | 1.46 | 15.13 |
| 73.70 | 4.30 | 0.2907 | 0.4489 | 1.79 | 18.32 |
| 94.63 | 4.55 | 0.2944 | 0.4530 | 2.15 | 21.87 |
| 121.51 | 4.80 | 0.2984 | 0.4576 | 2.56 | 25.75 |
| 156.02 | 5.05 | 0.3028 | 0.4625 | 3.01 | 29.90 |
| 200.34 | 5.30 | 0.3073 | 0.4676 | 3.51 | 34.30 |
| 257.24 | 5.55 | 0.3121 | 0.4731 | 4.06 | 38.94 |
| 330.30 | 5.80 | 0.3171 | 0.4788 | 4.66 | 44.25 |
| 424.11 | 6.05 | 0.3224 | 0.4847 | 5.32 | 54.84 |
| 544.57 | 6.30 | 0.3280 | 0.4908 | 6.04 | 68.77 |
| 699.24 | 6.55 | 0.3339 | 0.4972 | 6.83 | 86.26 |
| 897.85 | 6.80 | 0.3401 | 0.5370 | 7.70 | 108.16 |
| 1,152.86 | 7.05 | 0.3465 | 0.5104 | 8.66 | 136.72 |
| 1,480.30 | 7.30 | 0.3533 | 0.5172 | 9.70 | 173.32 |
| 1,900.74 | 7.55 | 0.3605 | 0.5243 | 10.84 | 219.60 |
| 2,440.60 | 7.80 | 0.3679 | 0.5314 | 12.09 | 277.74 |
| 3,133.79 | 8.05 | 0.3757 | 0.5388 | 13.44 | 350.09 |
| 4,023.87 | 8.30 | 0.3839 | 0.5464 | 14.92 | 439.05 |
| 5,166.75 | 8.55 | 0.3926 | 0.5543 | 16.53 | 546.74 |
| 6,634.24 | 8.80 | 0.4016 | 0.5623 | 18.28 | 687.78 |
| 8,518.54 | 9.05 | 0.4108 | 0.5705 | 20.18 | 876.84 |
| 10,938.02 | 9.3 | 0.4202 | 0.5787 | 22.26 | 1,100.50 |
| 14,044.69 | 9.55 | 0.4298 | 0.5870 | 24.52 | 1,370.20 |

Nondimensional Plate Data for Aspect Ratio = 2.2

| Nondimensional Lateral Pressure | Natural Logarithm of Nondimensional Lateral Pressure | Mass Equivalency Factor | Load Equivalency Factor | Nondimensional Maximum Deflection | Nondimensional Maximum Stress |
|---------------------------------|--|-------------------------|-------------------------|-----------------------------------|-------------------------------|
| \hat{q} | $\ln[\hat{q}]$ | K_M | K_L | $\hat{\delta}$ | $\hat{\sigma}$ |
| 9.97 | 2.30 | 0.2826 | 0.4400 | 0.25 | 2.87 |
| 12.81 | 2.55 | 0.2828 | 0.4030 | 0.32 | 3.69 |
| 16.44 | 2.80 | 0.2831 | 0.4406 | 0.41 | 4.72 |
| 21.12 | 3.05 | 0.2836 | 0.4411 | 0.53 | 6.03 |
| 27.11 | 3.30 | 0.2842 | 0.4418 | 0.67 | 7.67 |
| 34.81 | 3.55 | 0.2853 | 0.4429 | 0.86 | 9.71 |
| 44.70 | 3.80 | 0.2867 | 0.4445 | 1.08 | 12.21 |
| 57.40 | 4.05 | 0.2886 | 0.4465 | 1.35 | 15.22 |
| 73.70 | 4.30 | 0.2909 | 0.4492 | 1.66 | 18.73 |
| 94.63 | 4.55 | 0.2936 | 0.4522 | 2.03 | 22.76 |
| 121.51 | 4.80 | 0.2967 | 0.4558 | 2.45 | 27.28 |
| 156.02 | 5.05 | 0.3001 | 0.4598 | 2.93 | 32.22 |
| 200.34 | 5.30 | 0.3038 | 0.4641 | 3.45 | 37.53 |
| 257.24 | 5.55 | 0.3077 | 0.4687 | 4.02 | 43.22 |
| 330.30 | 5.80 | 0.3120 | 0.4737 | 4.65 | 49.15 |
| 424.11 | 6.05 | 0.3166 | 0.4790 | 5.34 | 55.53 |
| 544.57 | 6.30 | 0.3215 | 0.4845 | 6.10 | 66.68 |
| 699.24 | 6.55 | 0.3267 | 0.4903 | 6.93 | 83.80 |
| 897.85 | 6.80 | 0.3322 | 0.4963 | 7.84 | 105.26 |
| 1,152.86 | 7.05 | 0.3380 | 0.5024 | 8.83 | 133.00 |
| 1,480.30 | 7.30 | 0.3440 | 0.5087 | 9.92 | 168.91 |
| 1,900.74 | 7.55 | 0.3504 | 0.5152 | 11.11 | 214.39 |
| 2,440.60 | 7.80 | 0.3571 | 0.5218 | 12.42 | 271.60 |
| 3,133.79 | 8.05 | 0.3641 | 0.5286 | 13.83 | 342.90 |
| 4,023.87 | 8.30 | 0.3716 | 0.5358 | 15.38 | 430.86 |
| 5,166.75 | 8.55 | 0.3796 | 0.5432 | 17.06 | 537.61 |
| 6,634.24 | 8.80 | 0.3880 | 0.5508 | 18.89 | 674.37 |
| 8,518.54 | 9.05 | 0.3967 | 0.5587 | 20.88 | 861.50 |
| 10,938.02 | 9.30 | 0.4058 | 0.5667 | 23.04 | 1,083.10 |
| 14,044.69 | 9.55 | 0.4153 | 0.5750 | 25.38 | 1,344.50 |

Nondimensional Plate Data for Aspect Ratio = 2.4

| Nondimen- sional Later- al Pressure | Natural Log- arithm of Nondimen- sional Lat- eral Pressure | Mass Equivalency Factor | Load Equivalency Factor | Nondimen- sional Maxi- mum Deflection | Nondimen- sional Maxi- mum Stress |
|---|---|-------------------------------|-------------------------------|--|---|
| \hat{q} | $\ln[\hat{q}]$ | K_M | K_L | $\hat{\delta}$ | $\hat{\sigma}$ |
| 9.97 | 2.30 | 0.2881 | 0.4570 | 0.22 | 2.75 |
| 12.81 | 2.55 | 0.2883 | 0.4459 | 0.29 | 3.52 |
| 16.44 | 2.80 | 0.2884 | 0.4460 | 0.37 | 4.51 |
| 21.12 | 3.05 | 0.2886 | 0.4462 | 0.47 | 5.78 |
| 27.11 | 3.30 | 0.2889 | 0.4466 | 0.60 | 7.38 |
| 34.81 | 3.55 | 0.2894 | 0.4471 | 0.76 | 9.40 |
| 44.70 | 3.80 | 0.2900 | 0.4479 | 0.97 | 11.92 |
| 57.40 | 4.05 | 0.2910 | 0.4490 | 1.22 | 15.01 |
| 73.70 | 4.30 | 0.2924 | 0.4506 | 1.53 | 18.73 |
| 94.63 | 4.55 | 0.2941 | 0.4527 | 1.89 | 23.13 |
| 121.51 | 4.80 | 0.2962 | 0.4552 | 2.32 | 28.18 |
| 156.02 | 5.05 | 0.2986 | 0.4582 | 2.80 | 33.85 |
| 200.34 | 5.30 | 0.3015 | 0.4617 | 3.34 | 40.07 |
| 257.24 | 5.55 | 0.3047 | 0.4656 | 3.94 | 46.77 |
| 330.30 | 5.80 | 0.3082 | 0.4698 | 4.61 | 53.94 |
| 424.11 | 6.05 | 0.3122 | 0.4745 | 5.33 | 61.41 |
| 544.57 | 6.30 | 0.3165 | 0.4794 | 6.12 | 69.22 |
| 699.24 | 6.55 | 0.3210 | 0.4847 | 6.99 | 81.05 |
| 897.85 | 6.80 | 0.3259 | 0.4901 | 7.94 | 102.01 |
| 1,152.86 | 7.05 | 0.3311 | 0.4958 | 8.97 | 129.06 |
| 1,480.30 | 7.30 | 0.3365 | 0.5150 | 10.11 | 164.22 |
| 1,900.74 | 7.55 | 0.3422 | 0.5075 | 11.35 | 208.81 |
| 2,440.60 | 7.80 | 0.3482 | 0.5136 | 12.71 | 264.97 |
| 3,133.79 | 8.05 | 0.3545 | 0.5199 | 14.19 | 335.06 |
| 4,023.87 | 8.30 | 0.3613 | 0.5265 | 15.80 | 421.50 |
| 5,166.75 | 8.55 | 0.3685 | 0.5334 | 17.55 | 526.39 |
| 6,634.24 | 8.80 | 0.3762 | 0.5405 | 19.46 | 661.73 |
| 8,518.54 | 9.05 | 0.3842 | 0.5479 | 21.54 | 845.59 |
| 10,938.02 | 9.30 | 0.3928 | 0.5557 | 23.79 | 1,062.60 |
| 14,044.69 | 9.55 | 0.4019 | 0.5637 | 26.24 | 1,323.70 |

Nondimensional Plate Data for Aspect Ratio = 2.6

| Nondimen- sional Later- al Pressure | Natural Log- arithm of Nondimen- sional Lat- eral Pressure | Mass Equivalency Factor | Load Equivalency Factor | Nondimen- sional Maxi- mum Deflection | Nondimen- sional Maxi- mum Stress |
|---|---|-------------------------------|-------------------------------|--|---|
| \hat{q} | $\ln[\hat{q}]$ | K_M | K_L | $\hat{\delta}$ | $\hat{\sigma}$ |
| 9.97 | 2.30 | 0.2942 | 0.4170 | 0.20 | 2.61 |
| 12.81 | 2.55 | 0.2941 | 0.4517 | 0.25 | 3.35 |
| 16.44 | 2.80 | 0.2942 | 0.4518 | 0.32 | 4.30 |
| 21.12 | 3.05 | 0.2942 | 0.4518 | 0.42 | 5.51 |
| 27.11 | 3.30 | 0.2942 | 0.4519 | 0.53 | 7.06 |
| 34.81 | 3.55 | 0.2943 | 0.4520 | 0.68 | 9.02 |
| 44.70 | 3.80 | 0.2944 | 0.4523 | 0.87 | 11.49 |
| 57.40 | 4.05 | 0.2947 | 0.4527 | 1.10 | 14.59 |
| 73.70 | 4.30 | 0.2951 | 0.4534 | 1.39 | 18.41 |
| 94.63 | 4.55 | 0.2958 | 0.4544 | 1.74 | 23.02 |
| 121.51 | 4.80 | 0.2968 | 0.4558 | 2.16 | 28.47 |
| 156.02 | 5.05 | 0.2983 | 0.4579 | 2.65 | 34.76 |
| 200.34 | 5.30 | 0.3003 | 0.4604 | 3.20 | 41.81 |
| 257.24 | 5.55 | 0.3027 | 0.4635 | 3.82 | 49.55 |
| 330.30 | 5.80 | 0.3056 | 0.4670 | 4.51 | 57.88 |
| 424.11 | 6.05 | 0.3088 | 0.4710 | 5.27 | 66.77 |
| 544.57 | 6.30 | 0.3125 | 0.4753 | 6.09 | 76.06 |
| 699.24 | 6.55 | 0.3165 | 0.4800 | 7.00 | 85.71 |
| 897.85 | 6.80 | 0.3209 | 0.4850 | 7.99 | 98.38 |
| 1,152.86 | 7.05 | 0.3255 | 0.4901 | 9.07 | 124.89 |
| 1,480.30 | 7.30 | 0.3303 | 0.4955 | 10.25 | 159.23 |
| 1,900.74 | 7.55 | 0.3355 | 0.5100 | 11.55 | 202.84 |
| 2,440.60 | 7.80 | 0.3408 | 0.5066 | 12.96 | 257.81 |
| 3,133.79 | 8.05 | 0.3466 | 0.5125 | 14.50 | 326.41 |
| 4,023.87 | 8.30 | 0.3526 | 0.5186 | 16.18 | 410.82 |
| 5,166.75 | 8.55 | 0.3591 | 0.5249 | 18.00 | 512.95 |
| 6,634.24 | 8.80 | 0.3660 | 0.5315 | 19.99 | 649.19 |
| 8,518.54 | 9.05 | 0.3734 | 0.5384 | 22.15 | 828.50 |
| 10,938.02 | 9.30 | 0.3814 | 0.5457 | 24.50 | 1,038.80 |
| 14,044.69 | 9.55 | 0.3898 | 0.5533 | 27.05 | 1,306.70 |

Nondimensional Plate Data for Aspect Ratio = 2.8

| Nondimensional Lateral Pressure | Natural Logarithm of Nondimensional Lateral Pressure | Mass Equivalency Factor | Load Equivalency Factor | Nondimensional Maximum Deflection | Nondimensional Maximum Stress |
|---------------------------------|--|-------------------------|-------------------------|-----------------------------------|-------------------------------|
| \hat{q} | $\ln[\hat{q}]$ | K_M | K_L | $\hat{\delta}$ | $\hat{\sigma}$ |
| 9.97 | 2.30 | 0.3003 | 0.4578 | 0.17 | 2.48 |
| 12.81 | 2.55 | 0.3004 | 0.4579 | 0.22 | 3.19 |
| 16.44 | 2.80 | 0.3002 | 0.4577 | 0.29 | 4.09 |
| 21.12 | 3.05 | 0.3003 | 0.4578 | 0.37 | 5.25 |
| 27.11 | 3.30 | 0.3001 | 0.4577 | 0.47 | 6.72 |
| 34.81 | 3.55 | 0.2999 | 0.4576 | 0.60 | 8.61 |
| 44.70 | 3.80 | 0.2997 | 0.4575 | 0.77 | 11.01 |
| 57.40 | 4.05 | 0.2993 | 0.4573 | 0.99 | 14.05 |
| 73.70 | 4.30 | 0.2990 | 0.4573 | 1.26 | 17.85 |
| 94.63 | 4.55 | 0.2987 | 0.4573 | 1.59 | 22.56 |
| 121.51 | 4.80 | 0.2988 | 0.4578 | 1.99 | 28.25 |
| 156.02 | 5.05 | 0.2993 | 0.4587 | 2.47 | 34.98 |
| 200.34 | 5.30 | 0.3002 | 0.4603 | 3.03 | 42.74 |
| 257.24 | 5.55 | 0.3018 | 0.4624 | 3.66 | 51.43 |
| 330.30 | 5.80 | 0.3039 | 0.4652 | 4.37 | 60.96 |
| 424.11 | 6.05 | 0.3065 | 0.4678 | 5.16 | 71.23 |
| 544.57 | 6.30 | 0.3095 | 0.4722 | 6.02 | 82.15 |
| 699.24 | 6.55 | 0.3130 | 0.4763 | 6.97 | 93.60 |
| 897.85 | 6.80 | 0.3168 | 0.4808 | 8.00 | 105.50 |
| 1,152.86 | 7.05 | 0.3209 | 0.4855 | 9.13 | 120.84 |
| 1,480.30 | 7.30 | 0.3253 | 0.4904 | 10.36 | 154.09 |
| 1,900.74 | 7.55 | 0.3299 | 0.4955 | 11.70 | 197.03 |
| 2,440.60 | 7.80 | 0.3349 | 0.5008 | 13.17 | 251.49 |
| 3,133.79 | 8.05 | 0.3400 | 0.5063 | 14.77 | 319.92 |
| 4,023.87 | 8.30 | 0.3455 | 0.5119 | 16.52 | 404.80 |
| 5,166.75 | 8.55 | 0.3513 | 0.5177 | 18.42 | 508.42 |
| 6,634.24 | 8.80 | 0.3576 | 0.5238 | 20.49 | 634.12 |
| 8,518.54 | 9.05 | 0.3643 | 0.5302 | 22.75 | 815.86 |
| 10,938.02 | 9.30 | 0.3715 | 0.5370 | 25.19 | 1,032.50 |
| 14,044.69 | 9.55 | 0.3793 | 0.5441 | 27.85 | 1,281.10 |

Nondimensional Plate Data for Aspect Ratio = 3.0

| Nondimen- sional Later- al Pressure | Natural Log- arithm of Nondimen- sional Lat- eral Pressure | Mass Equivalency Factor | Load Equivalency Factor | Nondimen- sional Maxi- mum Deflection | Nondimen- sional Maxi- mum Stress |
|---|---|-------------------------------|-------------------------------|--|---|
| \hat{q} | $\ln[\hat{q}]$ | K_M | K_L | $\hat{\delta}$ | $\hat{\sigma}$ |
| 9.97 | 2.30 | 0.3067 | 0.4640 | 0.15 | 2.36 |
| 12.81 | 2.55 | 0.3066 | 0.4640 | 0.20 | 3.03 |
| 16.44 | 2.80 | 0.3066 | 0.4640 | 0.26 | 3.89 |
| 21.12 | 3.05 | 0.3066 | 0.4639 | 0.33 | 4.99 |
| 27.11 | 3.30 | 0.3063 | 0.4637 | 0.42 | 6.40 |
| 34.81 | 3.55 | 0.3059 | 0.4634 | 0.54 | 8.20 |
| 44.70 | 3.80 | 0.3055 | 0.4631 | 0.69 | 10.51 |
| 57.40 | 4.05 | 0.3048 | 0.4626 | 0.88 | 13.45 |
| 73.70 | 4.30 | 0.3039 | 0.4620 | 1.13 | 17.18 |
| 94.63 | 4.55 | 0.3029 | 0.4614 | 1.44 | 21.85 |
| 121.51 | 4.80 | 0.3020 | 0.4608 | 1.82 | 27.64 |
| 156.02 | 5.05 | 0.3014 | 0.4608 | 2.28 | 34.63 |
| 200.34 | 5.30 | 0.3014 | 0.4612 | 2.83 | 42.89 |
| 257.24 | 5.55 | 0.3020 | 0.4624 | 3.47 | 52.38 |
| 330.30 | 5.80 | 0.3032 | 0.4642 | 4.19 | 63.00 |
| 424.11 | 6.05 | 0.3051 | 0.4667 | 5.00 | 74.61 |
| 544.57 | 6.30 | 0.3074 | 0.4698 | 5.90 | 87.10 |
| 699.24 | 6.55 | 0.3103 | 0.4733 | 6.88 | 100.44 |
| 897.85 | 6.80 | 0.3136 | 0.4773 | 7.96 | 114.39 |
| 1,152.86 | 7.05 | 0.3172 | 0.4816 | 9.13 | 128.89 |
| 1,480.30 | 7.30 | 0.3212 | 0.4861 | 10.41 | 148.53 |
| 1,900.74 | 7.55 | 0.3254 | 0.4909 | 11.81 | 190.39 |
| 2,440.60 | 7.80 | 0.3299 | 0.4958 | 13.33 | 243.52 |
| 3,133.79 | 8.05 | 0.3346 | 0.5008 | 14.99 | 310.31 |
| 4,023.87 | 8.30 | 0.3395 | 0.5060 | 16.81 | 393.15 |
| 5,166.75 | 8.55 | 0.3448 | 0.5114 | 18.78 | 494.07 |
| 6,634.24 | 8.80 | 0.3505 | 0.5171 | 20.93 | 620.99 |
| 8,518.54 | 9.05 | 0.3566 | 0.5230 | 23.27 | 798.29 |
| 10,938.02 | 9.30 | 0.3631 | 0.5293 | 25.81 | 1,008.10 |
| 14,044.69 | 9.55 | 0.3702 | 0.5359 | 28.57 | 1,255.30 |

Nondimensional Plate Data for Aspect Ratio = 3.2

| Nondimen- sional Later- al Pressure | Natural Log- arithm of Nondimen- sional Lat- eral Pressure | Mass Equivalency Factor | Load Equivalency Factor | Nondimen- sional Maxi- mum Deflection | Nondimen- sional Maxi- mum Stress |
|---|---|-------------------------------|-------------------------------|--|---|
| \hat{q} | $\ln[\hat{q}]$ | K_M | K_L | $\hat{\delta}$ | $\hat{\sigma}$ |
| 9.97 | 2.30 | 0.3131 | 0.4702 | 0.14 | 2.24 |
| 12.81 | 2.55 | 0.3133 | 0.4703 | 0.18 | 2.88 |
| 16.44 | 2.80 | 0.3131 | 0.4702 | 0.23 | 3.69 |
| 21.12 | 3.05 | 0.3129 | 0.4701 | 0.29 | 4.74 |
| 27.11 | 3.30 | 0.3127 | 0.4699 | 0.38 | 6.08 |
| 34.81 | 3.55 | 0.3123 | 0.4696 | 0.48 | 7.81 |
| 44.70 | 3.80 | 0.3117 | 0.4692 | 0.62 | 10.01 |
| 57.40 | 4.05 | 0.3108 | 0.4685 | 0.79 | 12.84 |
| 73.70 | 4.30 | 0.3096 | 0.4675 | 1.02 | 16.44 |
| 94.63 | 4.55 | 0.3089 | 0.4663 | 1.30 | 21.01 |
| 121.51 | 4.80 | 0.3063 | 0.4651 | 1.65 | 26.75 |
| 156.02 | 5.05 | 0.3048 | 0.4640 | 2.09 | 33.86 |
| 200.34 | 5.30 | 0.3036 | 0.4634 | 2.62 | 42.42 |
| 257.24 | 5.55 | 0.3032 | 0.4635 | 3.25 | 52.51 |
| 330.30 | 5.80 | 0.3034 | 0.4643 | 3.98 | 64.07 |
| 424.11 | 6.05 | 0.3044 | 0.4660 | 4.81 | 76.96 |
| 544.57 | 6.30 | 0.3061 | 0.4683 | 5.73 | 91.04 |
| 699.24 | 6.55 | 0.3084 | 0.4712 | 6.75 | 106.15 |
| 897.85 | 6.80 | 0.3111 | 0.4746 | 7.87 | 122.29 |
| 1,152.86 | 7.05 | 0.3143 | 0.4784 | 9.09 | 139.13 |
| 1,480.30 | 7.30 | 0.3178 | 0.4826 | 1.04 | 156.59 |
| 1,900.74 | 7.55 | 0.3216 | 0.4869 | 1.19 | 183.76 |
| 2,440.60 | 7.80 | 0.3257 | 0.4915 | 1.35 | 236.10 |
| 3,133.79 | 8.05 | 0.3300 | 0.4962 | 1.52 | 302.37 |
| 4,023.87 | 8.30 | 0.3345 | 0.5011 | 1.71 | 385.25 |
| 5,166.75 | 8.55 | 0.3394 | 0.5062 | 1.91 | 487.18 |
| 6,634.24 | 8.80 | 0.3445 | 0.5114 | 2.13 | 610.04 |
| 8,518.54 | 9.05 | 0.3500 | 0.5169 | 2.38 | 782.65 |
| 10,938.02 | 9.30 | 0.3560 | 0.5227 | 2.64 | 997.69 |
| 14,044.69 | 9.55 | 0.3624 | 0.5289 | 2.93 | 1,246.10 |

Nondimensional Plate Data for Aspect Ratio = 3.4

| Nondimen- sional Later- al Pressure | Natural Log- arithm of Nondimen- sional Lat- eral Pressure | Mass Equivalency Factor | Load Equivalency Factor | Nondimen- sional Maxi- mum Deflection | Nondimen- sional Maxi- mum Stress |
|---|---|-------------------------------|-------------------------------|--|---|
| \hat{q} | $\ln[\hat{q}]$ | K_M | K_L | $\hat{\delta}$ | $\hat{\sigma}$ |
| 9.97 | 2.30 | 0.3198 | 0.4765 | 0.12 | 2.13 |
| 12.81 | 2.55 | 0.3197 | 0.4765 | 0.16 | 2.74 |
| 16.44 | 2.80 | 0.3197 | 0.4764 | 0.20 | 3.51 |
| 21.12 | 3.05 | 0.3196 | 0.4764 | 0.26 | 4.51 |
| 27.11 | 3.30 | 0.3192 | 0.4760 | 0.34 | 5.79 |
| 34.81 | 3.55 | 0.3188 | 0.4757 | 0.43 | 7.43 |
| 44.70 | 3.80 | 0.3182 | 0.4752 | 0.56 | 9.54 |
| 57.40 | 4.05 | 0.3173 | 0.4745 | 0.71 | 12.24 |
| 73.70 | 4.30 | 0.3158 | 0.4733 | 0.91 | 15.70 |
| 94.63 | 4.55 | 0.3139 | 0.4718 | 1.17 | 20.12 |
| 121.51 | 4.80 | 0.3117 | 0.4701 | 1.50 | 25.74 |
| 156.02 | 5.05 | 0.3093 | 0.4682 | 1.91 | 32.79 |
| 200.34 | 5.30 | 0.3071 | 0.4666 | 2.41 | 41.49 |
| 257.24 | 5.55 | 0.3055 | 0.4656 | 3.02 | 51.94 |
| 330.30 | 5.80 | 0.3047 | 0.4654 | 3.75 | 64.21 |
| 424.11 | 6.05 | 0.3047 | 0.4660 | 4.58 | 78.20 |
| 544.57 | 6.30 | 0.3056 | 0.4674 | 5.52 | 93.75 |
| 699.24 | 6.55 | 0.3071 | 0.4696 | 6.57 | 110.68 |
| 897.85 | 6.80 | 0.3093 | 0.4725 | 7.72 | 128.83 |
| 1,152.86 | 7.05 | 0.3119 | 0.4758 | 8.99 | 148.10 |
| 1,480.30 | 7.30 | 0.3150 | 0.4795 | 10.38 | 168.21 |
| 1,900.74 | 7.55 | 0.3184 | 0.4835 | 11.88 | 189.04 |
| 2,440.60 | 7.80 | 0.3222 | 0.4877 | 13.52 | 227.65 |
| 3,133.79 | 8.05 | 0.3261 | 0.4922 | 15.30 | 292.06 |
| 4,023.87 | 8.30 | 0.3303 | 0.4967 | 17.24 | 372.51 |
| 5,166.75 | 8.55 | 0.3347 | 0.5014 | 19.36 | 471.17 |
| 6,634.24 | 8.80 | 0.3394 | 0.5063 | 21.67 | 591.38 |
| 8,518.54 | 9.05 | 0.3444 | 0.5114 | 24.18 | 764.91 |
| 10,938.02 | 9.30 | 0.3498 | 0.5168 | 26.91 | 971.57 |
| 14,044.69 | 9.55 | 0.3557 | 0.5226 | 29.87 | 1,208.00 |

Nondimensional Plate Data for Aspect Ratio = 3.6

| Nondimen- sional Later- al Pressure | Natural Log- arithm of Nondimen- sional Lat- eral Pressure | Mass Equivalency Factor | Load Equivalency Factor | Nondimen- sional Maxi- mum Deflection | Nondimen- sional Maxi- mum Stress |
|---|---|-------------------------------|-------------------------------|--|---|
| \hat{q} | $\ln[\hat{q}]$ | K_M | K_L | $\hat{\delta}$ | $\hat{\sigma}$ |
| 9.97 | 2.30 | 0.3263 | 0.4826 | 0.11 | 2.03 |
| 12.81 | 2.55 | 0.3263 | 0.4827 | 0.14 | 2.60 |
| 16.44 | 2.80 | 0.3261 | 0.4825 | 0.18 | 3.34 |
| 21.12 | 3.05 | 0.3260 | 0.4824 | 0.24 | 4.29 |
| 27.11 | 3.30 | 0.3258 | 0.4823 | 0.30 | 5.51 |
| 34.81 | 3.55 | 0.3254 | 0.4819 | 0.39 | 7.07 |
| 44.70 | 3.80 | 0.3247 | 0.4818 | 0.50 | 9.08 |
| 57.40 | 4.05 | 0.3238 | 0.4806 | 0.64 | 11.66 |
| 73.70 | 4.30 | 0.3224 | 0.4795 | 0.82 | 14.97 |
| 94.63 | 4.55 | 0.3203 | 0.4779 | 1.06 | 19.22 |
| 121.51 | 4.80 | 0.3177 | 0.4758 | 1.36 | 24.65 |
| 156.02 | 5.05 | 0.3147 | 0.4734 | 1.73 | 31.54 |
| 200.34 | 5.30 | 0.3116 | 0.4709 | 2.21 | 40.19 |
| 257.24 | 5.55 | 0.3089 | 0.4688 | 2.79 | 50.81 |
| 330.30 | 5.80 | 0.3069 | 0.4675 | 3.50 | 63.55 |
| 424.11 | 6.05 | 0.3059 | 0.4670 | 4.32 | 78.41 |
| 544.57 | 6.30 | 0.3058 | 0.4675 | 5.28 | 95.28 |
| 699.24 | 6.55 | 0.3066 | 0.4689 | 6.35 | 113.95 |
| 897.85 | 6.80 | 0.3081 | 0.4710 | 7.53 | 134.19 |
| 1,152.86 | 7.05 | 0.3102 | 0.4738 | 8.84 | 155.82 |
| 1,480.30 | 7.30 | 0.3128 | 0.4770 | 10.28 | 178.81 |
| 1,900.74 | 7.55 | 0.3158 | 0.4807 | 11.84 | 202.72 |
| 2,440.60 | 7.80 | 0.3192 | 0.4846 | 13.54 | 227.44 |
| 3,133.79 | 8.05 | 0.3228 | 0.4887 | 15.38 | 283.03 |
| 4,023.87 | 8.30 | 0.3267 | 0.4930 | 17.39 | 363.13 |
| 5,166.75 | 8.55 | 0.3308 | 0.4975 | 19.58 | 462.40 |
| 6,634.24 | 8.80 | 0.3351 | 0.5020 | 21.97 | 582.74 |
| 8,518.54 | 9.05 | 0.3397 | 0.5068 | 24.56 | 747.10 |
| 10,938.02 | 9.30 | 0.3446 | 0.5118 | 27.38 | 958.19 |
| 14,044.69 | 9.55 | 0.3500 | 0.5172 | 30.45 | 1,203.10 |

Nondimensional Plate Data for Aspect Ratio = 3.8

| Nondimen- sional Later- al Pressure | Natural Log- arithm of Nondimen- sional Lat- eral Pressure | Mass Equivalency Factor | Load Equivalency Factor | Nondimen- sional Maxi- mum Deflection | Nondimen- sional Maxi- mum Stress |
|---|---|-------------------------------|-------------------------------|--|---|
| \hat{q} | $\ln[\hat{q}]$ | K_M | K_L | $\hat{\delta}$ | $\hat{\sigma}$ |
| 9.97 | 2.30 | 0.3325 | 0.4884 | 0.10 | 1.93 |
| 12.81 | 2.55 | 0.3324 | 0.4884 | 0.13 | 2.48 |
| 16.44 | 2.80 | 0.3326 | 0.4885 | 0.17 | 3.19 |
| 21.12 | 3.05 | 0.3324 | 0.4884 | 0.21 | 4.09 |
| 27.11 | 3.30 | 0.3322 | 0.4882 | 0.27 | 5.25 |
| 34.81 | 3.55 | 0.3317 | 0.4878 | 0.35 | 6.74 |
| 44.70 | 3.80 | 0.3312 | 0.4874 | 0.45 | 8.66 |
| 57.40 | 4.05 | 0.3304 | 0.4868 | 0.58 | 11.12 |
| 73.70 | 4.30 | 0.3290 | 0.4856 | 0.75 | 14.29 |
| 94.63 | 4.55 | 0.3270 | 0.4841 | 0.96 | 18.35 |
| 121.51 | 4.80 | 0.3243 | 0.4819 | 1.23 | 23.58 |
| 156.02 | 5.05 | 0.3209 | 0.4791 | 1.58 | 30.26 |
| 200.34 | 5.30 | 0.3171 | 0.4761 | 2.02 | 38.73 |
| 257.24 | 5.55 | 0.3134 | 0.4731 | 2.57 | 49.34 |
| 330.30 | 5.80 | 0.3102 | 0.4706 | 3.25 | 62.29 |
| 424.11 | 6.05 | 0.3080 | 0.4690 | 4.06 | 77.75 |
| 544.57 | 6.30 | 0.3068 | 0.4684 | 5.01 | 95.68 |
| 699.24 | 6.55 | 0.3067 | 0.4689 | 6.09 | 115.88 |
| 897.85 | 6.80 | 0.3075 | 0.4702 | 7.30 | 138.13 |
| 1,152.86 | 7.05 | 0.3090 | 0.4724 | 8.65 | 162.15 |
| 1,480.30 | 7.30 | 0.3111 | 0.4751 | 10.13 | 187.76 |
| 1,900.74 | 7.55 | 0.3137 | 0.4783 | 11.75 | 214.98 |
| 2,440.60 | 7.80 | 0.3167 | 0.4819 | 13.51 | 243.15 |
| 3,133.79 | 8.05 | 0.3200 | 0.4857 | 15.42 | 273.72 |
| 4,023.87 | 8.30 | 0.3236 | 0.4898 | 17.50 | 353.01 |
| 5,166.75 | 8.55 | 0.3274 | 0.4940 | 19.76 | 452.02 |
| 6,634.24 | 8.80 | 0.3314 | 0.4983 | 22.22 | 573.07 |
| 8,518.54 | 9.05 | 0.3356 | 0.5028 | 24.90 | 728.21 |
| 10,938.02 | 9.30 | 0.3402 | 0.5075 | 27.81 | 941.41 |
| 14,044.69 | 9.55 | 0.3451 | 0.5152 | 30.99 | 1,191.90 |

Nondimensional Plate Data for Aspect Ratio = 4.0

| Nondimensional Lateral Pressure | Natural Logarithm of Nondimensional Lateral Pressure | Mass Equivalency Factor | Load Equivalency Factor | Nondimensional Maximum Deflection | Nondimensional Maximum Stress |
|---------------------------------|--|-------------------------|-------------------------|-----------------------------------|-------------------------------|
| \hat{q} | $\ln[\hat{q}]$ | K_M | K_L | $\hat{\delta}$ | $\hat{\sigma}$ |
| 9.97 | 2.30 | 0.3390 | 0.4943 | 0.09 | 1.84 |
| 12.81 | 2.55 | 0.3385 | 0.4939 | 0.12 | 2.37 |
| 16.44 | 2.80 | 0.3387 | 0.4941 | 0.15 | 3.04 |
| 21.12 | 3.05 | 0.3386 | 0.4940 | 0.19 | 3.91 |
| 27.11 | 3.30 | 0.3384 | 0.4938 | 0.25 | 5.01 |
| 34.81 | 3.55 | 0.3381 | 0.4936 | 0.32 | 6.44 |
| 44.70 | 3.80 | 0.3375 | 0.4932 | 0.41 | 8.27 |
| 57.40 | 4.05 | 0.3367 | 0.4925 | 0.53 | 10.62 |
| 73.70 | 4.30 | 0.3356 | 0.4916 | 0.68 | 13.64 |
| 94.63 | 4.55 | 0.3337 | 0.4901 | 0.87 | 17.53 |
| 121.51 | 4.80 | 0.3310 | 0.4880 | 1.12 | 22.53 |
| 156.02 | 5.05 | 0.3275 | 0.4851 | 1.44 | 28.96 |
| 200.34 | 5.30 | 0.3233 | 0.4817 | 1.84 | 37.19 |
| 257.24 | 5.55 | 0.3188 | 0.4780 | 2.36 | 47.61 |
| 330.30 | 5.80 | 0.3146 | 0.4745 | 3.00 | 60.59 |
| 424.11 | 6.05 | 0.3111 | 0.4718 | 3.78 | 76.35 |
| 544.57 | 6.30 | 0.3088 | 0.4700 | 4.71 | 95.03 |
| 699.24 | 6.55 | 0.3076 | 0.4695 | 5.80 | 116.52 |
| 897.85 | 6.80 | 0.3075 | 0.4700 | 7.03 | 140.59 |
| 1,152.86 | 7.05 | 0.3083 | 0.4717 | 8.41 | 166.95 |
| 1,480.30 | 7.30 | 0.3099 | 0.4736 | 9.92 | 195.33 |
| 1,900.74 | 7.55 | 0.3120 | 0.4763 | 11.60 | 225.62 |
| 2,440.60 | 7.80 | 0.3146 | 0.4795 | 13.41 | 257.30 |
| 3,133.79 | 8.05 | 0.3176 | 0.4830 | 15.39 | 290.20 |
| 4,023.87 | 8.30 | 0.3209 | 0.4868 | 17.53 | 339.27 |
| 5,166.75 | 8.55 | 0.3244 | 0.4907 | 19.86 | 434.95 |
| 6,634.24 | 8.80 | 0.3281 | 0.4648 | 22.40 | 551.60 |
| 8,518.54 | 9.05 | 0.3320 | 0.4990 | 25.16 | 709.91 |
| 10,938.02 | 9.30 | 0.3363 | 0.5034 | 28.16 | 915.02 |
| 14,044.69 | 9.55 | 0.3408 | 0.5081 | 31.43 | 1,153.20 |

Nondimensional Plate Data for Aspect Ratio = 4.2

| Nondimensional Lateral Pressure | Natural Logarithm of Nondimensional Lateral Pressure | Mass Equivalency Factor | Load Equivalency Factor | Nondimensional Maximum Deflection | Nondimensional Maximum Stress |
|---------------------------------|--|-------------------------|-------------------------|-----------------------------------|-------------------------------|
| \hat{q} | $\ln[\hat{q}]$ | K_M | K_L | $\hat{\delta}$ | $\hat{\sigma}$ |
| 9.97 | 2.30 | 0.3447 | 0.4996 | 0.08 | 1.76 |
| 12.81 | 2.55 | 0.3447 | 0.4995 | 0.11 | 2.26 |
| 16.44 | 2.80 | 0.3446 | 0.4995 | 0.14 | 2.91 |
| 21.12 | 3.05 | 0.3444 | 0.4993 | 0.18 | 3.73 |
| 27.11 | 3.30 | 0.3443 | 0.4993 | 0.23 | 4.79 |
| 34.81 | 3.55 | 0.3441 | 0.4991 | 0.29 | 6.15 |
| 44.70 | 3.80 | 0.3436 | 0.4987 | 0.37 | 7.90 |
| 57.40 | 4.05 | 0.3430 | 0.4983 | 0.48 | 10.15 |
| 73.70 | 4.30 | 0.3420 | 0.4974 | 0.62 | 13.04 |
| 94.63 | 4.55 | 0.3403 | 0.4961 | 0.79 | 16.76 |
| 121.51 | 4.80 | 0.3378 | 0.4941 | 1.02 | 21.55 |
| 156.02 | 5.05 | 0.3344 | 0.4914 | 1.31 | 27.72 |
| 200.34 | 5.30 | 0.3300 | 0.4878 | 1.68 | 35.65 |
| 257.24 | 5.55 | 0.3250 | 0.4837 | 2.16 | 45.79 |
| 330.30 | 5.80 | 0.3199 | 0.4794 | 2.76 | 58.59 |
| 424.11 | 6.05 | 0.3152 | 0.4756 | 3.51 | 74.46 |
| 544.57 | 6.30 | 0.3116 | 0.4727 | 4.42 | 93.59 |
| 699.24 | 6.55 | 0.3093 | 0.4710 | 5.49 | 116.07 |
| 897.85 | 6.80 | 0.3082 | 0.4705 | 6.73 | 141.73 |
| 1,152.86 | 7.05 | 0.3082 | 0.4711 | 8.13 | 170.29 |
| 1,480.30 | 7.30 | 0.3091 | 0.4726 | 9.68 | 201.39 |
| 1,900.74 | 7.55 | 0.3108 | 0.4748 | 11.39 | 234.71 |
| 2,440.60 | 7.80 | 0.3130 | 0.4776 | 13.27 | 270.12 |
| 3,133.79 | 8.05 | 0.3156 | 0.4808 | 15.31 | 307.06 |
| 4,023.87 | 8.30 | 0.3186 | 0.4843 | 17.53 | 345.30 |
| 5,166.75 | 8.55 | 0.3218 | 0.4880 | 19.94 | 423.50 |
| 6,634.24 | 8.80 | 0.3253 | 0.4919 | 22.55 | 540.55 |
| 8,518.54 | 9.05 | 0.3290 | 0.4959 | 25.40 | 689.82 |
| 10,938.02 | 9.30 | 0.3329 | 0.5000 | 28.49 | 896.68 |
| 14,044.69 | 9.55 | 0.3371 | 0.5044 | 31.85 | 1,139.90 |

Nondimensional Plate Data for Aspect Ratio = 4.4

| Nondimen- sional Later- al Pressure | Natural Log- arithm of Nondimen- sional Lat- eral Pressure | Mass Equivalency Factor | Load Equivalency Factor | Nondimen- sional Maxi- mum Deflection | Nondimen- sional Maxi- mum Stress |
|---|---|-------------------------------|-------------------------------|--|---|
| \hat{q} | $\ln[\hat{q}]$ | K_M | K_L | $\hat{\delta}$ | $\hat{\sigma}$ |
| 9.97 | 2.30 | 0.3509 | 0.5051 | 0.08 | 1.69 |
| 12.81 | 2.55 | 0.3505 | 0.5048 | 0.10 | 2.17 |
| 16.44 | 2.80 | 0.3504 | 0.5048 | 0.13 | 2.78 |
| 21.12 | 3.05 | 0.3503 | 0.5047 | 0.16 | 3.57 |
| 27.11 | 3.30 | 0.3503 | 0.5047 | 0.21 | 4.59 |
| 34.81 | 3.55 | 0.3500 | 0.5044 | 0.27 | 5.89 |
| 44.70 | 3.80 | 0.3497 | 0.5042 | 0.34 | 7.56 |
| 57.40 | 4.05 | 0.3491 | 0.5038 | 0.44 | 9.71 |
| 73.70 | 4.30 | 0.3482 | 0.5030 | 0.56 | 12.48 |
| 94.63 | 4.55 | 0.3468 | 0.5019 | 0.72 | 16.04 |
| 121.51 | 4.80 | 0.3446 | 0.5002 | 0.93 | 20.62 |
| 156.02 | 5.05 | 0.3414 | 0.4976 | 1.20 | 26.53 |
| 200.34 | 5.30 | 0.3371 | 0.4942 | 1.54 | 34.15 |
| 257.24 | 5.55 | 0.3318 | 0.4899 | 1.98 | 43.95 |
| 330.30 | 5.80 | 0.3260 | 0.4850 | 2.54 | 56.45 |
| 424.11 | 6.05 | 0.3203 | 0.4803 | 3.25 | 72.18 |
| 544.57 | 6.30 | 0.3154 | 0.4762 | 4.12 | 91.51 |
| 699.24 | 6.55 | 0.3119 | 0.4733 | 5.17 | 114.67 |
| 897.85 | 6.80 | 0.3097 | 0.4717 | 6.40 | 141.63 |
| 1,152.86 | 7.05 | 0.3087 | 0.4714 | 7.81 | 172.14 |
| 1,480.30 | 7.30 | 0.3089 | 0.4722 | 9.40 | 205.82 |
| 1,900.74 | 7.55 | 0.3100 | 0.4738 | 11.15 | 242.28 |
| 2,440.60 | 7.80 | 0.3117 | 0.4761 | 13.08 | 281.17 |
| 3,133.79 | 8.05 | 0.3140 | 0.4790 | 15.19 | 322.50 |
| 4,023.87 | 8.30 | 0.3166 | 0.4821 | 17.48 | 365.34 |
| 5,166.75 | 8.55 | 0.3196 | 0.4856 | 19.96 | 411.14 |
| 6,634.24 | 8.80 | 0.3228 | 0.4892 | 22.66 | 528.62 |
| 8,518.54 | 9.05 | 0.3263 | 0.4930 | 25.59 | 671.06 |
| 10,938.02 | 9.30 | 0.3299 | 0.4970 | 28.78 | 875.50 |
| 14,044.69 | 9.55 | 0.3338 | 0.5011 | 32.24 | 1,124.30 |

Nondimensional Plate Data for Aspect Ratio = 4.6

| Nondimensional Lateral Pressure | Natural Logarithm of Nondimensional Lateral Pressure | Mass Equivalency Factor | Load Equivalency Factor | Nondimensional Maximum Deflection | Nondimensional Maximum Stress |
|---------------------------------|--|-------------------------|-------------------------|-----------------------------------|-------------------------------|
| \hat{q} | $\ln[\hat{q}]$ | K_M | K_L | $\hat{\delta}$ | $\hat{\sigma}$ |
| 9.97 | 2.30 | 0.3565 | 0.5102 | 0.07 | 1.62 |
| 12.81 | 2.55 | 0.3559 | 0.5098 | 0.09 | 2.08 |
| 16.44 | 2.80 | 0.3557 | 0.5096 | 0.11 | 2.66 |
| 21.12 | 3.05 | 0.3557 | 0.5096 | 0.15 | 3.42 |
| 27.11 | 3.30 | 0.3559 | 0.5097 | 0.19 | 4.39 |
| 34.81 | 3.55 | 0.3554 | 0.5094 | 0.24 | 5.64 |
| 44.70 | 3.80 | 0.3554 | 0.5093 | 0.31 | 7.24 |
| 57.40 | 4.05 | 0.3549 | 0.5089 | 0.40 | 9.31 |
| 73.70 | 4.30 | 0.3540 | 0.5083 | 0.52 | 11.95 |
| 94.63 | 4.55 | 0.3528 | 0.5073 | 0.66 | 15.36 |
| 121.51 | 4.80 | 0.3509 | 0.5058 | 0.85 | 19.75 |
| 156.02 | 5.05 | 0.3481 | 0.5036 | 1.10 | 25.40 |
| 200.34 | 5.30 | 0.3441 | 0.5004 | 1.41 | 32.71 |
| 257.24 | 5.55 | 0.3389 | 0.4961 | 1.82 | 42.13 |
| 330.30 | 5.80 | 0.3327 | 0.4911 | 2.34 | 54.24 |
| 424.11 | 6.05 | 0.3262 | 0.4857 | 3.00 | 69.65 |
| 544.57 | 6.30 | 0.3202 | 0.4806 | 3.83 | 88.91 |
| 699.24 | 6.55 | 0.3153 | 0.4765 | 4.84 | 112.39 |
| 897.85 | 6.80 | 0.3118 | 0.4737 | 6.05 | 140.26 |
| 1,152.86 | 7.05 | 0.3099 | 0.4724 | 7.46 | 172.38 |
| 1,480.30 | 7.30 | 0.3092 | 0.4723 | 9.06 | 208.39 |
| 1,900.74 | 7.55 | 0.3096 | 0.4732 | 10.85 | 247.87 |
| 2,440.60 | 7.80 | 0.3108 | 0.4750 | 12.82 | 290.41 |
| 3,133.79 | 8.05 | 0.3127 | 0.4774 | 14.99 | 335.86 |
| 4,023.87 | 8.30 | 0.3150 | 0.4803 | 17.35 | 383.37 |
| 5,166.75 | 8.55 | 0.3177 | 0.4835 | 19.91 | 432.70 |
| 6,634.24 | 8.80 | 0.3207 | 0.4869 | 22.68 | 514.42 |
| 8,518.54 | 9.05 | 0.3239 | 0.4905 | 25.70 | 657.46 |
| 10,938.02 | 9.30 | 0.3273 | 0.4943 | 28.97 | 851.35 |
| 14,044.69 | 9.55 | 0.3310 | 0.4982 | 32.53 | 1,103.20 |

Nondimensional Plate Data for Aspect Ratio = 4.8

| Nondimensional Lateral Pressure | Natural Logarithm of Nondimensional Lateral Pressure | Mass Equivalency Factor | Load Equivalency Factor | Nondimensional Maximum Deflection | Nondimensional Maximum Stress |
|---------------------------------|--|-------------------------|-------------------------|-----------------------------------|-------------------------------|
| \hat{q} | $\ln[\hat{q}]$ | K_M | K_L | $\hat{\delta}$ | $\hat{\sigma}$ |
| 9.97 | 2.30 | 0.3610 | 0.5143 | 0.06 | 1.55 |
| 12.81 | 2.55 | 0.3616 | 0.5147 | 0.08 | 1.99 |
| 16.44 | 2.80 | 0.3610 | 0.5143 | 0.11 | 2.56 |
| 21.12 | 3.05 | 0.3609 | 0.5143 | 0.14 | 3.28 |
| 27.11 | 3.30 | 0.3609 | 0.5143 | 0.17 | 4.22 |
| 34.81 | 3.55 | 0.3609 | 0.5142 | 0.22 | 5.41 |
| 44.70 | 3.80 | 0.3607 | 0.5141 | 0.29 | 6.95 |
| 57.40 | 4.05 | 0.3603 | 0.5138 | 0.37 | 8.93 |
| 73.70 | 4.30 | 0.3596 | 0.5132 | 0.47 | 11.47 |
| 94.63 | 4.55 | 0.3586 | 0.5125 | 0.61 | 14.74 |
| 121.51 | 4.80 | 0.3570 | 0.5112 | 0.78 | 18.94 |
| 156.02 | 5.05 | 0.3546 | 0.5092 | 1.01 | 24.37 |
| 200.34 | 5.30 | 0.3510 | 0.5064 | 1.30 | 31.37 |
| 257.24 | 5.55 | 0.3460 | 0.5024 | 1.67 | 40.41 |
| 330.30 | 5.80 | 0.3398 | 0.4973 | 2.15 | 52.09 |
| 424.11 | 6.05 | 0.3327 | 0.4915 | 2.77 | 67.08 |
| 544.57 | 6.30 | 0.3257 | 0.4857 | 3.55 | 86.06 |
| 699.24 | 6.55 | 0.3195 | 0.4804 | 4.52 | 109.61 |
| 897.85 | 6.80 | 0.3148 | 0.4765 | 5.70 | 138.02 |
| 1,152.86 | 7.05 | 0.3117 | 0.4740 | 7.09 | 171.39 |
| 1,480.30 | 7.30 | 0.3100 | 0.4729 | 8.70 | 209.45 |
| 1,900.74 | 7.55 | 0.3097 | 0.4731 | 10.51 | 251.77 |
| 2,440.60 | 7.80 | 0.3103 | 0.4743 | 12.53 | 297.87 |
| 3,133.79 | 8.05 | 0.3117 | 0.4763 | 14.74 | 347.26 |
| 4,023.87 | 8.30 | 0.3136 | 0.4787 | 17.18 | 399.65 |
| 5,166.75 | 8.55 | 0.3160 | 0.4817 | 19.81 | 454.27 |
| 6,634.24 | 8.80 | 0.3188 | 0.4849 | 22.67 | 510.75 |
| 8,518.54 | 9.05 | 0.3218 | 0.4883 | 25.77 | 643.32 |
| 10,938.02 | 9.30 | 0.3250 | 0.4918 | 29.14 | 824.92 |
| 14,044.69 | 9.55 | 0.3284 | 0.4956 | 32.79 | 1,079.70 |

Nondimensional Plate Data for Aspect Ratio = 5.0

| Nondimen- sional Later- al Pressure | Natural Log- arithm of Nondimen- sional Lat- eral Pressure | Mass Equivalency Factor | Load Equivalency Factor | Nondimen- sional Maxi- mum Deflection | Nondimen- sional Maxi- mum Stress |
|---|---|-------------------------------|-------------------------------|--|---|
| \hat{q} | $\ln[\hat{q}]$ | K_M | K_L | $\hat{\delta}$ | $\hat{\sigma}$ |
| 9.97 | 2.30 | 0.3668 | 0.5194 | 0.06 | 1.49 |
| 12.81 | 2.55 | 0.3662 | 0.5189 | 0.08 | 1.92 |
| 16.44 | 2.80 | 0.3664 | 0.5191 | 0.10 | 2.46 |
| 21.12 | 3.05 | 0.3661 | 0.5189 | 0.13 | 3.16 |
| 27.11 | 3.30 | 0.3663 | 0.5190 | 0.16 | 4.05 |
| 34.81 | 3.55 | 0.3661 | 0.5189 | 0.21 | 5.20 |
| 44.70 | 3.80 | 0.3656 | 0.5185 | 0.27 | 6.68 |
| 57.40 | 4.05 | 0.3654 | 0.5184 | 0.34 | 8.58 |
| 73.70 | 4.30 | 0.3649 | 0.5180 | 0.44 | 11.02 |
| 94.63 | 4.55 | 0.3641 | 0.5173 | 0.56 | 14.16 |
| 121.51 | 4.80 | 0.3628 | 0.5163 | 0.72 | 18.20 |
| 156.02 | 5.05 | 0.3607 | 0.5146 | 0.93 | 23.40 |
| 200.34 | 5.30 | 0.3575 | 0.5121 | 1.20 | 30.12 |
| 257.24 | 5.55 | 0.3530 | 0.5085 | 1.54 | 38.80 |
| 330.30 | 5.80 | 0.3469 | 0.5036 | 1.99 | 50.03 |
| 424.11 | 6.05 | 0.3397 | 0.4977 | 2.56 | 64.52 |
| 544.57 | 6.30 | 0.3320 | 0.4913 | 3.29 | 83.07 |
| 699.24 | 6.55 | 0.3247 | 0.4851 | 4.22 | 106.40 |
| 897.85 | 6.80 | 0.3186 | 0.4800 | 5.35 | 135.04 |
| 1,152.86 | 7.05 | 0.3142 | 0.4763 | 6.72 | 169.29 |
| 1,480.30 | 7.30 | 0.3115 | 0.4742 | 8.32 | 209.03 |
| 1,900.74 | 7.55 | 0.3102 | 0.4735 | 10.14 | 253.90 |
| 2,440.60 | 7.80 | 0.3102 | 0.4740 | 12.19 | 303.35 |
| 3,133.79 | 8.05 | 0.3110 | 0.4754 | 14.46 | 356.80 |
| 4,023.87 | 8.30 | 0.3126 | 0.4775 | 16.94 | 413.72 |
| 5,166.75 | 8.55 | 0.3147 | 0.4801 | 19.66 | 473.97 |
| 6,634.24 | 8.80 | 0.3171 | 0.4830 | 22.60 | 536.40 |
| 8,518.54 | 9.05 | 0.3199 | 0.4862 | 25.79 | 627.07 |
| 10,938.02 | 9.30 | 0.3229 | 0.4896 | 29.25 | 801.10 |
| 14,044.69 | 9.55 | 0.3262 | 0.4932 | 33.01 | 1,053.50 |

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1. The purpose of this document is to provide information regarding the activities of the [redacted] in the [redacted] area.

2. The [redacted] has been observed in the [redacted] area, and it is believed that it is engaged in [redacted] activities.

3. It is recommended that the [redacted] be monitored closely, and that any further information regarding its activities be reported immediately.

4. The [redacted] is believed to be a member of the [redacted] organization, and it is believed that it is engaged in [redacted] activities.

5. It is recommended that the [redacted] be monitored closely, and that any further information regarding its activities be reported immediately.

6. The [redacted] is believed to be a member of the [redacted] organization, and it is believed that it is engaged in [redacted] activities.

7. It is recommended that the [redacted] be monitored closely, and that any further information regarding its activities be reported immediately.

8. The [redacted] is believed to be a member of the [redacted] organization, and it is believed that it is engaged in [redacted] activities.

9. It is recommended that the [redacted] be monitored closely, and that any further information regarding its activities be reported immediately.

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